THE STUDENT,

AND

INTELLECTUAL OBSERVER.

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WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

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(*With a Coloured Plate.*)

CHAPTER III.

THE FRANKS IN GAUL.

It was the beginning of the fifth century of our era, when the different branches of the great Teutonic race were making their grand and final movement upon the Western Empire. The name of Germans was known to the Romans at a rather early period, as embracing the numerous cognate tribes who occupied the centre of Europe, and who, no doubt pressed forward by the movements of other peoples from behind, were continually seeking to advance towards the west. Cæsar, when he entered upon the conquest of Gaul, encountered the Germans on the borders of that country, and drove them back. It continued to be the policy of the Romans to repress and conquer these peoples through the whole period of their supremacy in the west. Tacitus, before the close of the first century after Christ, describes their manners and condition, which appear to have borne a sufficiently close resemblance to those of the Gauls before they were Romanised. As with the ancient Gauls, the Germans were accompanied in war by their wives and families—it was, in fact, a necessary consequence of the migratory state in which

they lived—and their women cheered and encouraged them in battle, and attended to the wounded. Like the Gauls, in regard to their Druidesses, the Germans looked upon Womankind as possessing something divine in its character, and as communicating with the gods more easily than men; and Tacitus mentions as instances of the veneration thus paid to the sex, the examples of Velleda, and Aurinia, "and many others" (*et complureis alias*). Like the Gauls, as I have said on a former occasion, the men wore the *braccæ*, or breeches. They wore also a dress which fitted close to the body, and over it a *sagum*, or mantle. Tacitus tells us that the women adopted much the same clothing as the men, except that they were more usually clad in linen garments dyed purple, and that they did not extend the upper part of the dress into sleeves, but went with the whole arm naked, as well as the upper part of the breast.* This, as it will be remembered, was the costume of the goddesses in the Eddas, and it explains a provision, in that part of the early Frankish laws which was made for the protection of the female person. By the Salic law, if a free man squeezed a free woman's arm below the elbow, he was liable to a penalty of twelve hundred denarii; if it were above the elbow, the fine was raised to fourteen hundred denarii; and if he touched her breast, he was punished by a fine of eighteen hundred denarii. Women who required this protection evidently went with bare arms and bare breasts. We learn from the same laws that the Frankish women of this early period had their hair bound up on the head by a sort of cap or coif called an *obbo*, for one law provides that, "if any one derange a woman's hair, so that her obbo fall to the ground, he shall be condemned to a fine of fifteen solidi.†"

Tacitus praises highly the chastity of the German women, and assures us that the Germans were almost the only people among the barbarians who lived satisfied each with one wife, "except a very small number, who, not through licentiousness, but as a mark of nobility, seek to have many wives."‡ Polygamy we have seen, in the preceding chapter, among the Teutonic gods, and we shall soon find it prevailing among the Teutons who obtained possession of Gaul.

* "Nec alius feminis quam viris habitus, eosque purpura variant, partemque vestitus superioris in manicas non extendunt, nudæ brachia ac lacertos, sed et proxima pars pectoris patet."—Tacitus, "Germania," c. 17.

† "Si quis mulierem excapillaverit ut ei obbonis ad terra cadat, solidos xv. culpabilis judicetur."—"Lex Salica," c. 75.

‡ Nam prope soli barbarorum singulis uxoribus contenti sunt exceptis admodum paucis, qui non libidine sed ob nobilitatem plurimis nuptiis ambiuntur."—Tacitus, "Germania," c. 18.

Tacitus goes on to say that, among the Germans of his time, it was not the wife who brought a dower to the husband, but the husband who gave it to the wife. This was of course the *morgane-ghibu*, or morning-gift, the *morgen-gifu* of our Anglo-Saxon forefathers, a sort of marriage settlement, which was arranged on the eve of the marriage, but was given by the husband to the wife on the morning after the marriage was completed. It was, in itself, a sort of acknowledgement of woman's position. The historian adds that the parents and kindred were present to see that the terms of the gift were duly performed, and that it consisted not of objects intended for feminine indulgence, or for the gratification of female vanity, but of oxen, and a horse with its bridle, and a shield with spear and sword. These were the symbolical gifts—for symbolism prevails largely in the childhood of people—by which the wife was to understand that she was henceforth to consider herself the companion of her husband in his labours and dangers, to share with him his fortunes in peace and in war.

The Romans sought to conquer these Germans, and, during the flourishing period of the empire, they were successful, and drove them far back from the borders of Gaul; but as the Roman power in the west fell more and more into decline, the imperial government was first obliged to conciliate those whom it had formerly defied, and afterwards to rest upon their support. Captives taken in war were always treated as slaves, and at an early period Gaul began to receive large accessions of Teutonic servile population. Then the Romans adopted the policy of encouraging the German tribes to place colonies in the northern parts of Gaul, where the population was very thin, and, in return for the protection they received, they formed on this side the guard of the Roman province. They thus formed an extensive military colony, and the Romans knew them by the name of *læti*, in which we can hardly avoid recognizing the same word as the modern German *leute*, people. More than this, the Romans found that the Germans made better soldiers than any of their other barbarians, and they enlisted them into their armies and disciplined them. It was the impetuous charge of the German cohorts which decided the victory at Pharsalia. From this time it was the pride of successive emperors to possess German troops, and they made their body guards of German soldiers. After a while they formed the main force of the empire, and they were everywhere introduced into the offices of state, and even reached the imperial throne in the person of the Goth Maximinus, in the first half of the third century. In the fourth century the great officers of the

imperial court and army, and those who occupied the novel charges of counts of the domestics, dukes of the frontiers (*limites*), and masters of the soldiery (*magistri militiæ*), were almost all Franks, or Alemanni, or Goths, or Burgundians. Such a state of things could not constitute a permanent strength, and accordingly, the Western Empire presented a scene of continual turbulence, which encouraged the Teutonic peoples outside to seek their fortunes in it, while they began towards the fourth century to be pushed forward by the advance of masses of peoples of other races from behind. The Salian Franks, driven by the Saxons from their primitive establishment in the interior of Germany, established themselves in the country to the extreme north of Gaul, between the Scheldt and the Meuse, in the middle of the fourth century. But it was at the beginning of the century following that the great invasion of the Teutons began, and within a few years the whole of Gaul was divided in three great independent kingdoms, between the Franks, the Visigoths, and the Burgundians. In the first years of the sixth century, as the result of a long series of intrigues and wars, nearly the whole of Gaul fell under the domination of the Franks.

We can trace little of the social condition of the Teutonic conquerors of Gaul during the long period of the wars of invasion, and can only suppose that, as far at least as concerned the Franks, it differed not considerably from that described by Tacitus. No doubt the invaders were accompanied in their expeditions by their women and families, for we have a remarkable story in confirmation. One of the most formidable of the Frankish chieftains in the invasions of the earlier half of the fifth century was named Chlodio. His head quarters lay between Brussels and Louvaine. Having sent explorers to report upon the attractions of the country to the southward, he assembled the leaders of his people, caused himself to be elected their military leader, and plunged with the whole tribe into the forest of Charbonnière (*Carbonaria*), a part of the Ardennes. Issuing from the depths of the forest, these Franks suddenly made their appearance on the banks of the Scheldt, and after taking and destroying Tournai and Cambrai, and massacring their inhabitants, they overrun the country as far as the banks of the Somme. It was at the time when the great Aetius was commanding the Roman armies, and victoriously protecting the empire against the new invasions of the barbarians, and he hurried from Brittany, crossed the Somme, and found the Franks encamped at a place named by the Latin historians Helena, but supposed to be Lens in Artois. They were so far from anticipating the probability of an attack,

that they were busy celebrating, with barbaric grandeur, the marriage of one of their chieftains. A poet of Gaul, Sidonius Apollinaris, who wrote at this time, has left us a poem commemorating this event. He describes how, while the legions of Aetius and Majorianus were silently crossing the river, the hill beyond resounded with the noise of the nuptial festivities.

"Fors ripæ colle propinquo
Barbaricus resonabat hymen, Scythicisque choreis
Nubebat flavo similis nova nupta marito."
Sidon. Apollinar. "Panegyr. Majorian.," l. 219.

Suddenly the heads of the Roman legions appeared on the ground and the Franks were taken by surprise, and, after a short but vigorous resistance, they were defeated with great slaughter. They had made an attempt to carry off the provisions of the festival in their chariots, but both the bride and the feast fell into the hands of the victors. There, as the poet tells us, might be seen glittering on the waggons the scattered preparations for the feast of the barbaric nuptials, and the dishes thrown together pell-mell, and the dainties captured, and the great cauldrons crowned with sweet smelling garlands.

"Plaustris rutilare videres
Barbarici vaga festa tori, convictaque passim
Fercula, captivasque dapes, cirroque madente
Ferre coronatos redolentia serta lebetas."

Thus was Chlodio driven back in temporary disgrace upon his old hiding place in the forest of the Ardennes. The son of this Chlodio is called by the Latin chroniclers Meroveus, and by the French Mérovée, and he was the father of Clovis, who established the monarchy of the Franks, and from whom, as a Meroving, or son of Mérovée (it is the well-known Teutonic patronymic), the Frankish kings of the first race took the name of Merovingians.

The annals of the earlier period of Frankish history throw little light on the domestic character and condition of the people, and especially on that of female society. The Franks appear to have been distinguished from most of the other branches of the Teutonic race by their great ferocity and cruelty, and the story of their establishment in Gaul presents one continual and wearisome series of massacres and murders. We feel this painfully in reading through the narrative of Gregory of Tours, who seems as if he had only occupied himself with recording the crimes and vices of his countrymen and countrywomen. Women like Fredegond, and Brunehild, and many others whose names

are recorded in these annals, all of whom were women of high and lofty minds, appear as if born only to exercise a fatal influence on human society. Perhaps we must blame history itself, which at this period has delighted in recording that which is wicked, because it carried with it more thrilling interest, and while all these queens of evil influence are arresting our attention, we must not forget that it was a woman, Chlotild, the queen of Clovis, who led the Franks in the way to the truths of Christianity, and that it was another Frankish lady, Bertha, the daughter of king Charibert, who brought the truth of the Gospel from the land of the Franks into that of the Anglo-Saxons.

To use the phraseology of the modern French historical writers, the Franks, on their establishment in Gaul, came in face of two elements of civilization, the Roman element and the Christian element. They were barbarians in one point of view, and pagans in another. The Roman offered all the refinements of luxury, displayed splendid garments in rich materials, and dazzled with precious metals and jewels; the Christian urged the worthiness of poverty, the virtues of coarse apparel, and proscribed jewelry and ornament, except when used in the ceremonies or ornamentations of the church. The barbarians had soon begun to show a taste for Roman luxury, and, as they became acquainted with that people, they adopted more and more their manners and mode of life. The female sex, at least, adopted the Roman costume, and no longer appeared with naked arms and bosoms. The Roman ladies had themselves adopted some new fashions in dress, especially the *camisia*, from which word is derived the modern French word *chemise*, and which was introduced in the fourth century. It appears to have been an inner tunic, worn by women, and not laid aside at night; for Isidore gives the word, and tells us that it was derived from *cama*, a low Latin word for a bed, and that it was so called, "because we sleep in them in beds."* It was adopted by the Franks, and the name occurs in the Salic law. The camisia of queen Radegond (the saint) was embroidered with gold. The women, about the same time, brought into use a sort of buskins, or boots. The form of the tunic was modified by rounding it, and plaiting it in front.

The object of most importance to a woman was her hair, which in both sexes had in earlier times a political signification. A free man, or a free woman, always wore it long, and it was a grave

* "Camisias vocamus, quod in his dormimus in camis, id est, in stratis nostris."—Isidore.

offence to cut a woman's hair. By the law of the Burgundians, a free man who cut off the hair even of a woman who was a slave, was subject to a penalty, and a slave who cut off the hair of a free woman was punished by death. Unmarried girls were obliged to carry their hair loose without ornament, so that if a damsel was long unmarried, it was usual to say, "She remains in her hair," *remanet in capillo*. Married women might plait their hair, and adorn it with garlands, and with little fillets, called by the Franks *stapiones*, or *scapiones*—it is doubtful whether we ought to read the second letter as a *t* or a *c*.

With the Carlovingian period, the forms of society were becoming more firmly settled, but they underwent no radical change. The Roman type still prevailed in the female costume, and some further borrowings were made from the south, while whatever remained of the primitive dress of the Franks was rapidly disappearing. The usual dress of the women consisted of two tunics, of which the one underneath was longer and fitted closer than the other, and had close sleeves plaited at the wrist. The outer tunic was shorter and sat looser, with wide sleeves which reached only to the elbow. Bands of different colours adorned the extremities of this vestment, which appears always of a different colour from the under tunic. A band, or girdle, encircled the hips, and a head-cloth, which was often richly embroidered, covered the head and enveloped the shoulders, and sometimes descended almost to the ground. The hair was thus entirely concealed. This part of the dress was richly adorned, and often of very brilliant colours. Among new articles of dress introduced during the Carlovingian period, was one common to both sexes, called a cape (*capa*), a sort of mantle or cloak, which is said by the old writers to have been a revival of the Roman caracalla. It appears to have been susceptible of great display of ornament, for it was forbidden by the council of Metz in 888 on account of its extravagance.

The Franks were slow in receiving a taste for literature, and they have left us no pictorial representations of the female costume during the Merovingian period, and very little until rather late in that of the Carlovingian dynasty; and the illuminated manuscripts even of the latter period are all Bibles, or service books, or lives of saints, which contain only figures of sacred personages. Fortunately, however, these mediæval artists drew every body in the exact character and costume of their own time. The accompanying cut is a copy of an illuminated initial letter in a manuscript of the Latin Bible of the eight century, in which it forms one of the

letters of the first word of the Gospel of St. Luke. It was intended to represent the Visitation, and the two nimbuses show that the women are sacred personages, but they may be taken with equal truth for two Frankish ladies of the age of Charlemagne, embracing

each other. They are charming figures, dressed in the upper and under tunic as just described. The head-dresses are peculiar, and appear to be detached from the mantle or (perhaps) cape. In the figure to the left, the forepart of the hair is seen, divided in the middle, under the head-covering.

Our coloured plate is taken from a manuscript of the Latin Bible, written in the ninth century, and represents St. Jerome explaining the Holy Scriptures to the noble mother and daughter, Paula and Eustochia. They were two Roman ladies in whose house Jerome lived while he performed the duties of secretary to Pope Damasus. The lady nearest to Jerome is, by the richness of her costume, evidently Paula, and the next her daughter Eustochia, who had made a vow of virginity. The difference in the dress was intentional on the part of the illuminator, for we know that the dresses of married women were allowed to be much more rich, in material and ornament, than those of virgins. It may be well to

remark that the parts here coloured yellow, are gold in the original.

The next cut, also taken from a manuscript of the ninth century, represents two females, drest in the same costume. They wear, over the tunic, with the sleeves fitting tight to the wrist, a long robe which entirely covers the body, and has wide hanging sleeves.

There is a simplicity of character in the forms of this womanly costume, which gives a kind of imposing grace to the wearers. In this respect, they seèm to have undergone no perceptible change during the whole Frankish period, but in richness of material and of jewelry they differed greatly. We hear the old writers speaking continually of the costly embroidery of the dresses of the Frankish ladies, which was usually of gold. Silks had been introduced among them from an early period of their settlement in Gaul, and other costly materials are mentioned. Silk and fringes of gold are often mentioned by Gregory of Tours. The clergy exceeded even the laity in this extravagance, and the ladies of the convents (as well as the ecclesiastics of the other sex), prided themselves on the richness of their dresses, and on the quantity of jewels with which they covered their persons. The great jeweller of the Franks—the patron of the jeweller's craft—was St. Eligius (or St. Eloi, as he is called in French). Yet these same ecclesiastics are always complaining of the extravagance and vanity of the laity. A preacher of Marseilles, in the fifteenth century, named Claudius Marius Victor, made a violent attack upon the vanities of Womankind in that city, in which he accuses them of painting their faces; and it is spoken of as the practice among

these Frankish ladies, at least at one period, to have their hair curled by means of curling irons. The extravagance in dress and in the toilette during the Carlovingian period appears to have been excessive.

Before the Germans came into Gaul, women had already been employed, on a tolerably large scale, in productive labour. Among the Germans themselves, in their primitive period, the women of the household were employed constantly in weaving the materials and in making garments for their husbands and families. It was the case also among the Romans in Italy, where a name derived from the Greek, gynæceum, was given to the room set apart for the females, in which they assembled to work. In course of time, public establishments were formed, for the manufacture of the same products, in which women were similarly employed, and to which they gave the same name of gynæcea. They were placed under the direction of matrons, but a considerable proportion of the work-women were slaves. They were early introduced into Gaul, where they formed the nuclei of the staple manufactures of particular localities, the materials being confined in some of them to flax, and in others to wool. Thus the Attrebates monopolised the manufacture of serge, and the same article still continues to be one of the staple manufactures of Amiens, which represents one of their principal cities. St. Jerome speaks of the fine texture of the stuffs made in his time at the civitas Atrebatum, or Arras. After the settlement of the Franks, the native industry revived in Gaul, and the gynæcea were re-established, apparently on an extensive scale, for they soon became very numerous. The historian Gregory, of Tours (lib. ix.), tells us how a lady of the court of Theodebert, charged with plotting against the king's life, had her face branded, and was in that condition sent to the village of Marlheim, to be there employed in turning the mill, and in preparing the meal necessary for the nourishment of the women who dwelt in the gynæceum which existed in that place. The great fairs of Gaul, such as that of St. Denis, were supplied with merchandise from the gynæcea, and Italy and other countries sought their products. A capitular of Dagobert, of the date of A.D. 630, fixes the punishment of a man who violated the person of one of the women of the gynæceum at a fine of six solidi of gold. Under the Carlovingians, the gynæcea remained in full activity. That at Stephanswert, belonging to Charlemagne's own domain, contained twenty-four women employed in fabricating vestments of woollen and linen, and of fillets for the legs. Charlemagne published several enactments relating

to these establishments. In the celebrated capitular of the year 800, he enumerates the various implements and other things which were to be supplied to these workwomen. The great emperor was so anxious that Womankind should be employed in productive labour, that he made his own daughters work in the domestic gynæceum as diligently as the other females.

After the time of Charlemagne, the character of the women of the gynæcea began to fall into discredit. The old laws for the protection of their virtue were apparently no longer carried into effect, and corruption found its way in among them. It became customary to speak of the inmates of the gynæceum as mere courtezans, until at length this was the only sense in which the word was used.

RAMBLES OF A NATURALIST.*

Naturalists make by far the best travellers; indeed, it is rare to find a book of travels worth reading unless it is written by a man of science, or specially relates to important matters of art. Our country produces abundance of adventurous spirits who journey through the most inhospitable regions, and explore the most inaccessible countries; but how few, even of those who take a leading place amongst geographical discoverers, are able to bring home any valuable information about the tribes they have seen, the fauna, the flora, or the geology of the lands they have passed through. Dr. Collingwood appears in the work before us as a very good specimen of a rambling naturalist. He visited the China seas in government vessels, and thus had little choice in the details of his route, and frequently had to hurry through localities in which he would gladly have lingered, but he seems to have made the best of his opportunities, and whether on land or sea was always on the look out for interesting facts.

At Aden he found a rich store of marine animals, including the *Bornella digitata*, a beautiful sea slug. Creatures of this sort, he tells us, preserve their colours well in glycerine, "though it unfits them for dissection." A week's voyage from Aden carried him to the cocoa-nut groves and cinnamon gardens of Ceylon, and during

* "Rambles of a Naturalist on the Shores and Waters of the China Sea. Being Observations in Natural History during a voyage to China, Formosa, Borneo, Singapore, etc., made in Her Majesty's vessels, in 1866 and 1867." By Cuthbert Collingwood, M.A., M.B. Oxon, F.L.S., etc. Murray.

the passage his observing faculties were never idle or without reward. The uneducated traveller complains of a sea voyage being tiresome, but Dr. Collingwood remarks that "scarcely a day passes without some addition to one's stock of information, whether it be a fish swimming in the sea, a bird winging the air, or some floating delicate animal which would seem least fitted to buffet with the waves." This is true enough; but the gist of the thing lies in the fact of "adding" to one's information, and when there is no information to add to, the case is a hopeless one. In the Royal Navy we occasionally hear of an officer sufficiently instructed to be able to see the things which nature abundantly places before him; but the tone of the service is unfavourable to intellectual exercise, and most officers prefer what Dr. Collingwood terms, "the dull and unendurable monotony" of an ignorant sea life, to the recreations of the man of science. "Not one in a thousand," he says, "troubles himself to observe what passes around him;" and the reason is too plain; the governing powers care little for the progress of knowledge, and the way not to get on in the service, is to be above the regulation standard in cultivation or usefulness.

At Penang our traveller was much struck with the caricature plant (*Justicia picta*), every leaf of which exhibits a series of caricatures of the human face of the most grotesque character. Hong Kong he describes as presenting a varied and beautiful appearance when approached from the sea; but he found the police of the little island badly managed, and walking in the Chinese quarter far from secure. From Hong Kong he steamed to Protas Island (N. L. 20° 42′, Long. 116° 43′ E.), mainly inhabited by gannets, who have an amazing faculty of devouring flying fish. When gorged with this prey, the birds sit on their nests, and if a stranger approaches they have to throw their stomachic cargo overboard before they can take to flight. The dinners ejected before Dr. Collingwood consisted of sometimes "six or seven flying fish, in other instances only three or four, and in two or three cases a squid or two intermixed with them." At this island the curious phenomenon occurred of rollers dashing in from the S.W., though the wind was N.E.; this effect was occasioned by a typhoon blowing 200 or 300 miles further south, and curving round.

At Formosa, Dr. Collingwood met with the leaping fish (*Boleophthalmus Boddaertii*), salamandrine-looking animals, scarcely distinguishable from the mud on which they rested, until, on being alarmed, they made off in a series of rapid leaps, which caused the sailors to denominate them "Jumping Johnnies." They were not

confined to muddy shores, but were also found "among smooth, rocky places, up which they climb with great skill by a series of leaps, wriggling and curving the tail at each leap in a contrary direction, that is right and left alternately."

The use of the towing-net in the Formosa Channel was very successful, catching, amongst other forms, the glassy crustacean, *Alima hyalina*, "whose carapace seemed carved from the purest crystal, with an elegance of sculpturing and a sharpness of outline not to be surpassed;" and glass crabs (Phyllosoma), whose flat leaf-like bodies, and long branched legs seemed made of fine plates of clear mica."

Several new species rewarded Dr. Collingwood's researches in this neighbourhood and in the adjacent islands. At Slut Island he found a small shrimp belonging to the genus Alpheus, "of a deep violet colour, and with a claw of a very remarkable construction." "I placed it," he says, "in a basin of water with a small crab, whose presence appeared violently to offend it. Whenever the crab came in contact with the shrimp, the latter produced a loud sound, the explanation of which is as follows: the shrimp possessed two chelæ or claws, on the right a large and stout one, and the left one long and slender. When irritated it opened the pincers of the large claw very wide, and then suddenly closed them with a startling jerk. When the claw was in contact with the bottom of the basin a sound was produced as though the basin were smartly struck, but when the claw was elevated in the water, the sound was like a snap of the finger, and the water was splashed in my face." He called it the Trigger Shrimp, from the action of this claw resembling that of a pistol trigger. If only put upon half-cock this trigger closed without noise. Dr. Collingwood adds, "The peculiar clicking apparatus is by no means unusual, and is shared by another genus, Alope."

As a good specimen of Dr. Collingwood's descriptive powers, we must quote the account of his visit to Fiery Cross Reef on a day when the sea was so calm that the ship's anchor could be distinctly seen sixty or seventy feet from the surface. Rowing over a two fathom patch, he allowed the boat to drift slowly and gazed on the sea treasures. "Glorious masses of living coral strewed the bottom; immense globular madrepores, vast overhanging mushroom-shaped expansions, complicated ramifications of interweaving branches, mingled with smaller and more delicate species—round, finger-shaped, horn-like and umbrella form—lay in wondrous confusion, and these painted with every shade of delicate and brilliant colouring—grass green, deep blue, bright yellow, pure white, rich buff, and more

sober brown—altogether forming a kaleidoscopic effect of form and colour unequalled by anything I ever beheld. Here and there was a large clam shell (Chama), wedged in between masses of coral, the gaping zig-zag mouth covered with the projecting mantle of the deepest Prussian blue; beds of dark purple long spined echini, and the thick black bodies of sea-cucumbers (Holothuriæ), varied the aspect of the sea bottom. In and out of these coral groves, like gorgeous birds in forest trees, swam the most beautifully coloured and grotesque fishes, some of an intense blue, others bright red, others yellow, black, salmon-coloured, and every colour of the rainbow, curiously barred and bounded and bearded."

Naturalists frequently observe curious and friendly relations subsisting between creatures that might be supposed hostile to each other. One of these is related by Dr. Collingwood as occurring on the Fiery Cross Reef, and also near Labuan, where he discovered a magnificent anemone two feet in diameter, with numerous deep blue tentacles, and in the cavity of this creature elegant fish, about six inches long, seemed to make their abode or at any rate to seek shelter.

Labuan was found by Dr. Collingwood to offer a host of interesting objects to the attention of the naturalist. He also reports sufficiently well of the Labuan coal to lead to the belief that if the company for working it had been properly managed, success would have been the result. At Labuan, Singapore, and Johore, Dr. Collingwood met with a new species of crab, the "Pill-maker." It is a small creature of its kind, many being no bigger than large peas. Its habit is to take up particles of sand in its claws, deposit them in a groove beneath the thorax, and subsequently to eject them as little pellets or pills from its mouth after having extracted what nutriment they may contain.

We are quite sure the specimens we have given of the "Naturalist's Rambles in the China Seas," will cause our readers to get the book for themselves, and they cannot fail to be much pleased with a work in which every page contains interesting and valuable matter.

THE STONE AGE IN SCANDINAVIA.*

PROFESSOR NILSSON, who holds a distinguished position in the University of Lund, in Sweden, was one of the first, if not the first, at least in his own country, to call attention to the subject of the stone implements of which so much has been said of late. He tells us in this book that his attention was first called to the subject as a boy, when, in his fondness for hunting, and in consequence of the smallness of his gun, he was obliged to form his own gun-flints, and when, in his hunting-excursions, he found from time to time flints which had been formed into implements by the hand of man in very remote ages. This became with him a subject of study, and ended in his giving to the world a book upon what he calls the stone age in Scandinavia, which is here translated by Sir John Lubbock. He seeks in it to classify the ancient stone implements found in the north, and preserved in the northern museums, and to explain their particular characteristics, and the object for which each was made. All this is very good; we take his explanations with some reserve—many we receive willingly, and some we are inclined to reject. But Professor Nilsson's book is now brought forward as part of an extensive theory which obliges us to regard it with a more critical eye.

We fully believe in a stone age in one sense of the word; that is, we believe that, at least in most parts of the world, there was a primeval period before the man who dwelt in it was in the possession of metals, and when, therefore, he was obliged to form the simple instruments which were necessary for assuring his existence, of stone, or bone, or wood, which ever was most useful or readiest to his hand. We are also of the same opinion with Professor Nilsson, that the population being at that period necessarily scattered thinly over the land, and occupied merely in obtaining wherewith to support life, these rude implements were made, not for war, but for purposes of peace—for killing animals, birds, and fishes, and for producing the imperfect manufactures which were necessary for clothing and shelter. And Professor Nilsson does not exactly restrict this to an age, but to a particular condition of civilization. But the error into which he appears to us to have fallen, and which is shared by the modern school

* "The Primitive Inhabitants of Scandinavia." By Sven Nilsson. Third Edition, revised by the Author, and Translated from his own Manuscript. Edited, with an Introduction, by Sir John Lubbock, Bart., F.R.S., etc. 8vo. London: Longmans.

of prehistoric archæologists generally, is that of supposing that this condition of society belongs only to the prehistoric period; in fact, in neglecting altogether the study of the subsequent periods, and assuming that society progresses uniformly, and that at any given period the same people is uniformly civilized. Now this was certainly not the case. If we take our own island as an example, and come so late as the Roman period, it cannot be doubted that there was a very great difference in artificial civilization in different parts, resulting, among other causes, from the want of that facility and rapidity of intercommunication which exists in more modern times. Metal was not to be had everywhere, and, wherever it was to be had, it was, no doubt, dear. There were, doubtless, wild parts of the island where metal implements were almost unknown, or where, when wanted, they could only be obtained after long delay, and at great expense; or, where implements of metal were well known, there was a part of the population which was too poor to purchase them. In either case, the people who were deficient in metal implements would be obliged to make them for themselves of stone, or any other material which was ready at hand, and, while fully acknowledging the existence of a (probably long) period, during which metals were entirely unknown, we still cannot admit that the existence of any particular stone implement is evidence that, at the time it was made, metals were unknown among the people who made it, or that the form of any particular stone implement is a proof of its age. On the contrary, Nilsson himself, and, as we believe, his translator and editor, Sir John Lubbock, labours to show that, in all ages of the world, from the so-called stone period to the time in which we are now living, among people who made their implements of stone, those made for the same purposes have always been similar in form; in other words that, either the natural ideas of uncivilized man, or the natural capability of the material used, led to a uniformity of form of implements intended for the same purposes, among all peoples in a certain state of civilization, at all periods. The evident result of this appears to us to be, that the form of a stone implement is no evidence whatever of the date to which it belongs, and leads us rather naturally to reject all these limits, and divisions, and subdivisions of periods. It is, if we may be allowed to use the phrase, Darwinism applied to stone implements.

There is another argument employed by Professor Nilsson in regard to these flint-implements which we consider especially weak. He pleads (see p. 192) that the earliest writers of history, strictly

authentic or only traditional, when telling of the wars so far back as even the mythic ages, make mention of no other weapons than those of metal, and therefore, he argues, as we understand him, the stone implements must have belonged to an age far anterior to those ages. To this argument we have to oppose, first, the argument furnished by Nilsson himself, that the stone implements were intended for the occupations of peace, and not for war, and, secondly, that, in battles which would find a place in the narrative of the historian, weapons of stone must have been used by a class of combatants who would have escaped historical notice. There is also another argument brought forward by Professor Nilsson, which, if accepted in all its force, would not amount to much, but which, as it appears very ingenious and specious, and is based upon the authority of the classical writers, requires some examination. It is that implements of stone were used by the ancients during the historic period in their religious ceremonies in a manner which showed it to be a traditionary reminiscence of that remote period when no implements were known but those of stone. As will be seen at once, the force of this argument is very small, but we will examine briefly the authorities upon which it is based, if merely to show the extreme carelessness with which writers on these subjects sometimes carry on their researches.

We have been led to look upon Professor Nilsson as possessed of a not very critical mind. When in England, two or three years ago, he published a paper on Stonehenge which it would have been more to his credit as an archæologist had it never been printed; and we cannot resist the temptation of examining, in the present volume, the authorities he brings from ancient writers to show the usage of flint knives for religious persons, "many instances of which," he says, "occur in history" (p. 97). He begins with the Old Testament. "When," he says, "the Jews journeyed out of Egypt, they were already well acquainted with iron, and yet Zipporah, the wife of Moses, circumcised her son with a sharp stone; and when Joshua again introduced the sacrament of circumcision, which had been forgotten during the wandering in the desert, he used the same instrument that had formerly been used for that purpose, namely, *the stone knife.*" It appears that, in both these instances, the Hebrew words are of somewhat doubtful interpretation: whether they meant literally a knife made of stone (there is not a word about flint), or whether it was merely a phrase for a sharp knife, as it is translated in Joshua in most of the modern versions; and we are not aware, from other Jewish and biblical

authorities, that the Jews were in the habit, at known periods, of using stone knives for this purpose. If it were the case, it would only show a superstition in regard to the material used for this special purpose. It is not even suggested that circumcision was practised among the savages of the stone period. It is the same with the reference which Professor Nilsson makes to Herodotus, who, as he is here quoted, would give us to understand that in Egypt the practice of embalming was performed only with flint knives. This is not strictly the case: Herodotus says that iron was used in other parts of the process, but he adds that, in taking out the intestines, the Egyptian embalmers made an incision into the side with "an Ethiopian stone;" by which we are simply to understand that there was a superstition against touching the intestines with metal.

All this, it will be seen, has very little to do with the use of flint implements in prehistoric ages; but when Professor Nilsson comes to treat of the supposed traditions of the flint period in the classical ages, he is far less accurate. "The Phœnicians," he says, "likewise, after they had become acquainted with the use of metals, took sacred oaths at the altar in this manner. The person about to be sworn held *a lamb in the left hand, and a flint knife in the right*, vowing by gods and man that, if he broke the promise given, the god might slay him in the same way that he killed the lamb." The reference for this in the foot-note is, "Corn. Nep. *Hannib.*, edit. Kuchen.," quite indefinite enough to show that the writer had not been to the original to which he refers. In fact, we were quite surprised to think that a terse writer like Cornelius Nepos should have entered into all this detail, and we turn to his book, where, in his brief biography of Hannibal, chap. ii., he tells us of the famous oath against the Romans, which was taken by Hannibal from his father (it is Hannibal himself who tells the story):—

"Simul me ad aram adduxit apud quam sacrificare instituerat, eamque, ceteris remotis, tenentem jurare jussit nunquam me in amicitia cum Romanis fore."

i.e., "At the same time he led me to the altar, at which he had prepared to offer sacrifice; and, having sent the others away, commanded me, with my hand on the altar, to swear that I would never enter into friendship with the Romans." It will be seen that all this story about the lamb and the stone knife is a mere dream;—in the authority referred to, there is no mention of either. The same story is told, in much the same terms, by Valerius Maximus, lib.

ix., c. 3, and the commentators state that the ancient manner of taking a solemn oath was by laying the hand upon the altar while swearing.

There is clearly nothing about a flint knife here; and the Professor is equally unhappy in his next quotation:—"When the Horatii and the Curiatii were to decide the fate of Rome and Alba by single combat, the Romans were no doubt well acquainted with weapons of metal; and yet Livy relates ('Histor.,' chap. i. 24) that the priest, at the sacrifice, killed the victim *with a flint knife;* and other instances might be mentioned." We turn to Livy, *loc. cit.*, and find the form of the oath as follows (the correct reference is, lib. i., c. 25):—

"Si prior defexit publico consilio, dolo malo, tu illo die, Jupiter, populum Romanum sic ferito, ut ego hunc porcum hic hodie feriam: tantoque magis ferito, quanto majus potes pollesque? Id ubi dixit, porcum saxo silice percussit."

It is the representative of Rome who takes the oath; he says, "should the Roman people break their faith, 'do thou, on that day, Jupiter, strike them thus as I this day strike this pig; and strike them as much more as thou hast the power and might to strike.' When he had said that, he struck the pig with a flint stone." There is, in all this, not a word about flint knives, or of any implements made of flint, but simply of a natural flint. Any superstitious feeling associated with it had regard to the material, and not to any form which was given to it; and we can well understand how the stone from which fire was drawn might be associated in the popular imagination with the divinity of Jupiter. Had Professor Nilsson gone to the grammarian Festus, he would have found (lib. x.) the whole matter explained, for this writer tells us that the oath made in early times in the name of Jupiter was performed as follows:—

"Silicem tenebant juraturi per Jovem hæc verba dicentes: Si sciens fallo, tum me Diespiter, salva urbe arceque, bonis ejiciat, ut ego hanc lapidem."

"Those who were going to swear by Jupiter, held in their hands a flint, saying these words: If knowingly I fail, then may Jupiter, preserving the town and the citadel, cast me out of my goods as I cast away this stone." It was no doubt a rough flint which the taker of the oath was expected to throw away—not *a flint knife*. We believe that these allusions in the classical writers to the superstitious usage of flints, have no relation whatever with the employment of flint implements in the ages when metal was unknown.

We regret to see a man whose name stands at any elevation in

science treating upon serious subjects in this loose manner. The only excuse which can be offered is that Professor Nilsson has taken his authorities at second hand, without looking at the originals, and that he believed anything that people said in their names; and unfortunately he does this in almost every case we meet with. We turn to p. 72, and we find him quoting an author well known to every one acquainted with the history of the middle ages. "Reference," says the Professor, "has also been made to a sentence in Wilh. von Poitier's 'Historia Guilhelmi Conquestris' (it should of course be *Conquestoris*), in which he says," etc. Professor Nilsson has taken his quotation at second-hand from a German writer, and he seems to be thinking, from the form in which he found it there, "Wilhelm von Poitier," that he was some German writer, instead of being a tolerably well-known Norman Poet, Guillaume de Poitiers.

We will say no more. We accept the translation of the book of Professor Nilsson for his arrangement and attempts at explaining the numerous classes of stone implements found in Scandinavia, whether belonging to a stone age, or to any other age; and especially for the interesting plates which accompany it. His accomplished translator and editor, Sir John Lubbock, has printed with it an Essay of his own, already well known, in which he explains the system of prehistoric ages, as he always does everything, elegantly, pleasantly, and plausibly; but at the same time we confess that we hesitate in accepting it. Our business here, however, is only with Professor Nilsson.

HAS THE SURFACE OF THE MOON ATTAINED ITS FINAL CONDITION?

BY W. R. BIRT, F.R.A.S.,

Secretary, British Association Moon Committee.

DURING at least the last eighty years this question has been mooted by most of those astronomers who, although in the *minority* as regards the affirmative, have perhaps been more actively engaged in scrutinizing the moon's surface. Schröter, at the close of the last century, and Schmidt, in our own time, have announced changes in the appearances and characters of certain objects; new craters in some cases, the obscuration and disappearance of well-known objects in others. The announcement by Schmidt, towards the close of the year 1866, that the crater Linné had disappeared, has directed the attention of astronomers afresh to the subject. Schmidt, from his own observations during twenty-five years, appears to be confident that the crater has *really* undergone a physical change; while other astronomers, who, perhaps have not given the attention to the moon's surface which Schmidt has—from observations continued through a lunation or two—have concluded that Linné is still in its former condition, and have suggested that any pretended changes ought to be explained on the ground of observations which have been made under unfavourable circumstanses, combined with inexactitude in former drawings of the crater.

Among the objects recorded by Schröter are to be found, although but rarely, certain *black* spots, such as the fine black spot seen by Buckingham and Schmidt on Linné in December, 1866. Similar spots have been seen by our countryman Dawes, three particularly near Sulpicius Gallus, which were perfectly distinct, nearly round, and sharply defined, on June 10, 1867, but were nowhere to be found on June 13, 1867. This is not surprising, for if they should be small pits in a roughened surface, they may remain effectually concealed until two coincident circumstances recur, viz., the visual angle opening a channel for the rays amongst small eminences, and the direction of the terminator allowing the shadows to fall in the same way as on the 10th of June, 1867. The latter will not occur until the same period of the next lunar year, and depends on the distance of the moon's node from the sun, or

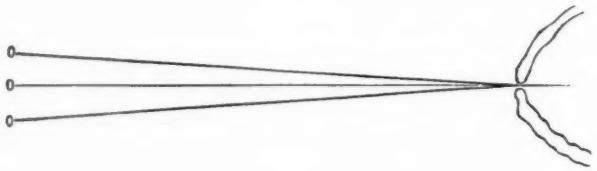
$\odot - \Omega$; for when this quantity $= 0°$, or the longitude of the node and sun, as seen from the moon, are equal, it is the spring equinox to the northern hemisphere of the moon. The visual angle has a longer period, which is dependent on a similar coincidence of the two librations in latitude and longitude. In addition to these circumstances, we have *the different conditions of our own atmosphere,* tending in no small degree to lead the mind to suspect change of a *physical character* when there has been *no* change, but only a concealment, as in a landscape, where a distant object is hidden by one not quite so remote; and this is not all, for we are really so very much unacquainted with the nature of the moon's surface, that it is impossible to say what may be in existence tending to produce an *apparent* change, while the object is in precisely the same state as when it was observed with great clearness and precision. Under such circumstances, it is of great importance to withhold our acquiescence in any supposed change *until proven.*

Astronomers are divided as to the real condition of the surface of our satellite, some regarding it in a state of "fixity," others in a state of "change." It must be in either the one or the other. The idea of "fixity" cannot be better expressed than in the language of Nasmyth (who, we all know, has paid great attention to the subject), as follows:—"In my opinion, no changes whatsoever are in progress on the moon—*no water, no atmosphere;* therefore, no *soil,* no vegetation, and no inhabitants."—(Crampton's "Lunar World," p. 132.) No language can so fully express the idea of *absolute fixity* than this. On the other hand, *change* runs through a variety of gradations, from the "slight cracking," as Mr. Nasmyth says, "from the contraction or expansion of the rocks, as the fierce heat of the sun gives way to, or succeeds, the terrible intensity of the cold, that will come on so rapidly, as soon as the sun has set, to the part in question * * the only agent of disintegration now in operation on the moon" (Crampton's "Lunar World," p. 136)—to the depression of a large tract of land as the plain east of Straight Wall, or the elevation of a mountain, as "Jorullo," which, it is right to say, Mr. Nasmyth regards as having ceased on the moon myriads of ages ago. If the moon's surface be really subject to change, it appears, from a comparison of observations on record, to have been indeed very slight. No observer, except Schmidt, has announced the detection of "change," and his instance is seriously and gravely questioned. To *prove* change on the moon's surface is extremely difficult; the impediments are very numerous, arising from libration, which constantly alters the visual angle; from the

oscillations of the equator of illumination, which materially affect the appearance of certain objects, rendering them sufficiently *dark* in *summer* and *light* in *winter* to arrest the attention, it may be, as *new objects;* from imperfection in the transparency; and from agitation of our own atmosphere rendering objects so indistinct at times as considerably to alter the appearance of some, and effectually to conceal others which, on a night of extremely *fine* definition stand out with marvellous distinctness; from irradiation, and circumstances which cannot be referred to either of the above heads, rendering, as I saw with Mr. Knott's Alvan Clark, of 7½-inches aperture, *under admirable definition,* FOUR very conspicuous objects, which I well knew, a *blurred mass,* while the neighbouring objects were beautifully distinct. All these are very serious obstacles to our endeavours to get at "change;" but, I apprehend, to prove "fixity" is still more difficult. It is true that, generally speaking, we recognize those objects with which we are familiar as presenting the same appearance, modified only by those circumstances which we know must affect them; but has any observer of the moon's surface, in preceding years or at present, so thoroughly *scanned* the surface, *jotted down* the positions of the objects, *measured* and *recorded* the appearance of ALL that can be seen, that such an observer can say, from *observation,* past and present, that any ONE particular object is *exactly* and *really* in the same physical state as when Galileo first beheld the moon through his wondrous tube—let alone the countless thousands of mountains, pits, craters, plains, and other objects, which we know have not yet been examined? If Mr. Nasmyth's view be correct, that "*although now almost gone by,* the only agent now in operation as a disintegrator is that of the alternate contraction and expansion of the rocks by heat and cold," *some change* must be taking place which, while invisible to, and probably beyond detection by us, is nevertheless real. Consequently, the idea of "fixity" is invalidated, and we are encouraged and urged onward to persevere in inquiring into the *present* state of the moon's surface, that our labours may be of advantage to those who succeed.

It has been suggested that fallacy may be detected by *noticing the recurrence of the same appearance which had been supposed to have passed away, or to have been superseded by other appearances.* There are, however, phenomena presented on the moon's surface indicating "form" which are very seldom seen; indeed, it may be many *years* before we may be able again to catch them. For example, the remarkable stream of light crossing "Plato" in the

direction of the longer axis, which was seen by Bianchini, August 16, 1725, and of which he gave a drawing in his work, "Hesperi et Phosphori." This drawing was copied by Schröter. This stream of light has not, to my knowledge, been seen *since*. From my own observations of Plato, which are not few, I am inclined to consider that this stream of light was thrown through a depression in the west wall which is very apparent, and which I have seen many times, even as late as the 11th of June, 1867. If the opening be *very narrow*, it is only at the time when the direction of the terminator forms a right angle with the length of the gorge that the stream of



light is thrown across the plain. At all other times it is thrown either towards the N. or S. walls, and may be very soon intercepted by the N. or S. walls of the gorge. If the west wall of Plato be *precisely* in the same state as when Bianchini observed this light streak, then we ought to have it in *those lunar years* when the angle which the morning terminator makes with the meridian *as it crosses the* W *edge of Plato* is the complement of the angle which the direction of the gorge makes with the meridian. Consequently, the time of its appearance is strictly within our power to calculate; and for this purpose the formula is very simple, the azimuth, as regards the lunar equator, being known. *Supposing* the opening to be slightly N. of a parallel, *i.e.*, the direction is very slightly N. of W. and S. of E., and makes an angle of 89° with the meridian. Bianchini's stream will fall across Plato when the value of $\odot - \delta = 41° \pm$, *i.e.*, provided the supposition be correct; but as this value occurs but once in the lunar year, between the spring equinox and summer solstice, northern hemisphere, and more frequently at times when the sun *is not rising upon Plato*, it is clear that Bianchini's stream can very rarely occur, and from the earth can be still more rarely seen. It follows, therefore, that it is not safe to regard the *total absence of a pheno-*

menon, even during an interval of 141 years, as indicating real change.

The only way, as it appears to me, to test an alleged change such as we have in the phenomena of Linné, is to collect and well weigh all the information bearing on the subject, both *ancient* and *modern*. Hitherto, the progress of selenography as depending on the comparison of drawings for fixing characters, or for determining change whether they be early or recent, has signally failed. I speak more of my own experience, at the same time with regard to others I am unable to lay my hand on any delineations of the moon's surface that would satisfy me, from a comparison of them *alone*, that *real* change has taken place. All the circumstances above alluded to are so many drawbacks to a true scientific determination of change. Under these adverse and almost disheartening circumstances we have, it may be, a clue to the unravelling of some of the mysterious phenomena occurring on the moon's surface; that which has been attended with such signal success in the investigation of binary stellar systems:—viz. measurement—may be employed with advantage on the moon's surface. Already it has enabled us to determine with equal accuracy as on the earth, the positions, heights, and depths of objects; and a *judicious* application of it to size may still further help us. I am not aware how far B. and M.'s and Lohrmann's measures for size can be depended on, the extents of objects are very freely scattered over both works, and B. and M. give, on pp. 88, 89 of "Der Mond," the formulæ, with an example of computation, also a table of determinations. Be this as it may, we are certainly able to obtain measures, accompanied by a description of the objects measured, which treated in a certain way, are likely to help us in our investigations. For very *close* determinations, each measure must be submitted to a somewhat troublesome computation, and this is by no means desirable, as small differences will inevitably be mixed up with the circumstances before mentioned. To decide on *real* change, we must have *salient* and *large* differences. Now we know that at the centre of the moon one second of arc covers a certain linear space, according to my computation, 1·1585 English miles, or 6116·7 English feet. At any given angular distance from the centre, 1″·0 will cover a *greater* space in the proportion of the secant of the angle. If, therefore, we measure the diameter of an object on the radius from the moon's centre, it is not difficult to calculate the extent of the measured line in English feet, and we can thus express the size in English feet and seconds of arc. Both Lohrmann and B. and M.

give the diameters of craters in geographical miles of 3807·1 toises each, which are equivalent to 24,344 English feet, and we have Schmidt's value for Linné 1·5, and B. and M.'s 1·4 geographical miles; these values subtend respectively 5·″17 and 4·″83 at the position of Linné on the radius at mean distance. The value of 1·″0 = 7056·6 English feet. On Oct. 18, 1866, Schmidt considered the whitish cloud which he found in the place of Linné, to be two geographical miles in extent; and on Dec. 27, 1866, only 2000 toises. In Dec. 1866, on the 15, 18, 19, 21; and on Jan. 14, 1867, I measured the white cloud on Linné, in a direction *at right angles to the parallel*. The measures varied from 6·″75 to 11·″61 or 4·″86, a greater quantity than can reasonably be ascribed to errors of observation. In July, 1867, measures made very carefully, varied from 5·″33 to 7·″0 in three days. Mr. Buckingham, on March 14, 1867, found the cloud 6·″0 in diameter. Combining these (of course involving the small errors arising from libration ±), we have a series of diameters referred to the radius varying from 12,790 to 81,920 English feet—a very large difference, and certainly unconnected with libration. The difference in seconds = 9·″80, which is very much greater than the difference of 25 sets of measures of Dionysius—viz. 4·″67. This difference in the measures of craters appears by no means to be a rare occurrence. Now, what does this depend upon? The measures of the white cloud "Linné" were made so near each other in Dec., 1866, and in July, 1867, that the varying distance of the moon could not produce so great a difference. It is difficult to conceive that the increasing or decreasing altitude of the sun could *alter the extent* of a reflective surface, although it would the intensity. Again, unsteadiness in the state of our atmosphere would tend to enlarge the measures, but the difference of 4·″5 in three days can hardly be referred to this cause. The series appears to point, 1°, to errors of observation or reading; 2°, to the state of our own atmosphere; or 3°, to an *increased* and *decreasing* extent of matter of a greater reflective power than the surface of the *mare*.

Were all the observations made by myself, I might well distrust them, but when Schmidt and Buckingham agree to within 1·″0, and I agree with Huggins to 0·″008, some of mine at least come into the category, and, with the exception of Schmidt's value of Dec. 27, 1867, and a measure by Joynson of 4·″42 on January 3, 1868, they give a *larger* extent for the white cloud than Lohrmann and B. and M. gave for the crater. The small crater of Secchi, which he estimated at $\frac{1}{3}$ of a second, with the small hill and black

point estimated by Schmidt at 1900 and 1700 English feet, would subtend an angle of about $\frac{1}{4}$ of a second. But Respighi makes the small crater 4·″0. Gathering up the results, we have four separate objects on record. The crater (B. and M.) (Grube, Lohrmann), 1087 English feet deep, having a mean diameter of 35,265 English feet; the whitish cloud (weisse wolke, of Schmidt), the largest measured diameter being 81,932 English feet, and the smallest 31,190 English feet. Schmidt's estimation on Dec. 27 was much smaller, viz., 12,790 English feet. The little hill of Schmidt, seen by Buckingham and others, of about 1900 English feet in diameter; and the little crater of Secchi, of about 2000 English feet in diameter, which has been seen by several observers.

How are these different objects to be treated? The questions that suggest themselves to my mind are numerous. Did the state of our atmosphere in Greece so effectually conceal the white hill and black point, that Schmidt did not see them during October and November? Was the state of our atmosphere so greatly improved in April that the little crater was seen more distinctly then than at any other time? Has a deep crater, which B. and M. probably measured, and to which *three* selenographers have assigned a diameter over one geographical mile (German), been so affected by some remarkable influence during the last few months, as to present the appearance of a hill or dot, and afterwards of a small crater of less than its seventeenth part. Has the older crater during a period of short duration shown itself—*still contracted in size*—to Respighi, while other observers speak of it as small. If it appears *smaller to us* in 1867 than it did to Lohrmann and B. and M. in 1823 and 1831, it is exceedingly important to ascertain the nature of the cause that is capable of so materially contracting it *in appearance*, while it remains precisely of the same size. If, on the other hand, the crater was never larger than it at present appears to us, it is quite as important to *prove* that B. and M. and Lohrmann were mistaken! Respighi says on this point: "Que si la carte lunaire de MM. Beer et Mädler donne au cratère des dimensions plus grande, ou doit l'attribuer a l'inexactitude du dessin inexactitude dont ou pourrait produire d'autres exemples bien plus manifestes; ou est d'autant plus fondé à le faire que dans le cas actuel il s'agit d'un objet représenté par un signe de convention plutôt que par un dessin veritable."

Another question suggests itself: What influence has produced the appearance of the whitish cloud seen on one occasion more than

twice as large as the crater recorded by Lohrmann and B. and M. Schmidt, in his paper on Linné, gives no observations between 1843, August 17, and 1866, Oct. 16. In 1842, July 14, Linné was drawn "als sehr kleiner crater." It is therefore very uncertain when the appearance recorded by Schmidt first occurred. On the other hand, it is quite certain that between 1866, Oct. 16, and the present date (June 28, 1866), we have enough on record to *prove* the *present state of Linné*, viz., the *larger* shallow crater, with the smaller crater within it—a state of things not at all hinted at in the earlier records. The whitish cloud is still existing, and is a very proper object for measurement in the present state of affairs. The black dot may or may not be seen again.* It appears to have been described as a crater, and a diameter of 4·″0 assigned to it. Its permanence, or fugitive character, it is very important to determine; but nothing I apprehend can settle the question but close and unremitting observation, which Linné has been the subject of since Schmidt's announcement.

On April 11, May 11, and June 10, I carefully examined Linné, and could find nothing like a crater with apertures of $4\frac{1}{4}$ and $8\frac{1}{4}$ inches.

* The small crater was seen and measured by Mr. Joynson on January 3, 1868. Its diameter was 1·″223, which is 0·″487 less than Mr. Huggins's measure of it on July 9, 1867.

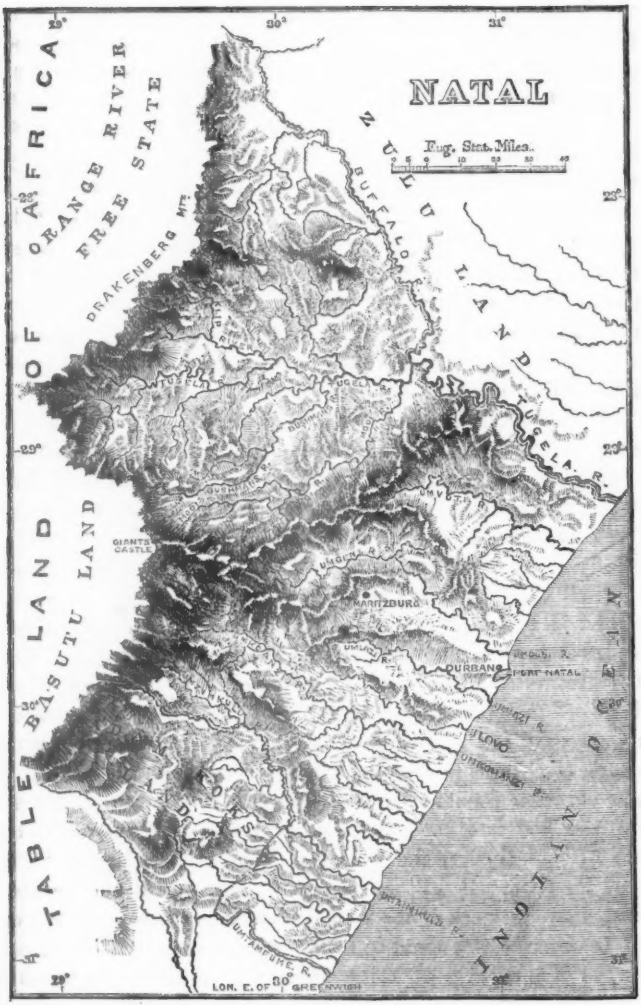
THE THUNDER-STORMS OF NATAL.

(With a Map and a Plate.)

THERE is a small colonial land, belonging to England, and furnishing a field for the growing enterprise of a now increasing band of English settlers, which lies in the further hemisphere of the earth, reaching at one point to within but little more than 200 miles of the Southern Tropic, where the scorching sun shines vertically down upon the ground at noon at the period of midsummer; but which, nevertheless, has a yearly mean temperature that, even on the low sea-coast, does not exceed 68° of the heat-scale of Fahrenheit, and an absolute temperature that, excepting upon rare occasions, when a hot land-wind, or Sirocco, prevails for a brief period, does not at the warmest period of the day exceed the heat experienced in an English summer. In this favoured land the sugar-cane, evergreen coffee, tobacco and cotton, Indian corn, the pine-apple, the banana, and the orange are at home; and so also, strange to say, are cattle, sheep, and horses, the grain and root-crops, and to a considerable extent, the trees, vegetables, and fruits of temperate Europe.

This remarkable result is brought about by the instrumentality of a power that is ordinarily deemed one of the most terrible of nature's agencies, but which here stands so manifestly stamped with a beneficent character and function, that it is literally stripped of its terrors and welcomed, day after day, nay almost courted, for the good it brings. The writer of this memoir, indeed, as having occupied somewhat the unfortunately responsible position of a clerk of the weather and, as it were, Rain-doctor, out in the land of which he is about to speak, has actually found himself on not rare occasions, exposed to the unmistakeable and very imperfectly repressed reproach of a partner and companion—who certainly had no particular affection for thunder and lightning in old days in England, before she had had the advantage of making its acquaintance in South Africa—because the afternoon thunder-storm lingered a little behind its time. It will be apparent, then, from this incidental avowal, that the clerk of the weather and Rain-doctor in question is about to describe this agent in the operations of nature, the thunder-storm, as it is capable of being studied in its favourite haunt and home, among the green hills of South-Eastern Africa, where it ordinarily assumes its grandest and most majestic aspect, while performing its beneficent office.

It is matter of familiar knowledge that the conversion of invisible


NATAL
Eng. Stat. Miles.
ZULULAND
TABLE LAND OF SOUTH AFRICA
BASUTU LAND
ORANGE RIVER FREE STATE
DRAKENBERG MT.
BUFFALO R.
TUGELA R.
GIANTS CASTLE
MARITZBURG
DURBAN
PORT NATAL
UMKOMAAS R.
UMTAMVUNA R.
UMZIMKULU R.
UMZIMVUBU R.
INDIAN OCEAN
LON. E. OF GREENWICH

vapour into visible mist and palpable water, is nature's main plan for the development or manufacture, so to speak, of electrical force. Energy, or power, that had been productively engaged in sustaining the watery principle in its more refined, elastic, and invisible state, is deprived of its occupation, and turned loose upon the world to find other work to do, when its invisible charge is taken from its hold and converted into visible cloud or rain; and can often be so observed in its unoccupied condition, on the outlook for another engagement. If the condensation of invisible vapour into visible mist be gradual and slow, the force set free has time and opportunity to scatter itself gently about, until it can secure fresh occupation in a quiet way. But if the condensation is rapid and great, the emancipated energy gathers too quickly, and in too large amount, for this quiet dispersion, and so, from time to time, bursts forth in overflowing power as vivid lightning. It follows, then, from this being the mode in which what is called free electricity is generated in the regions of the air, that in all places where the condensation of invisible vapour into visible mist and cloud is carried on in a slow and orderly way, the great visible manifestations of electrical disturbance, known as thunder-storms, are rarely seen; but in all places where the condensation is prone to be rapid and paroxysmal, thunder-storms are of frequent occurrence. Conditions which allow great quantities of invisible vapour, floating or streaming in the upper regions of the air, to be *suddenly* thrown down to the earth as palpable water, or as heavy rain, are then properly the material machinery which is employed by nature in the evolution of this class of tempestuous disturbance.

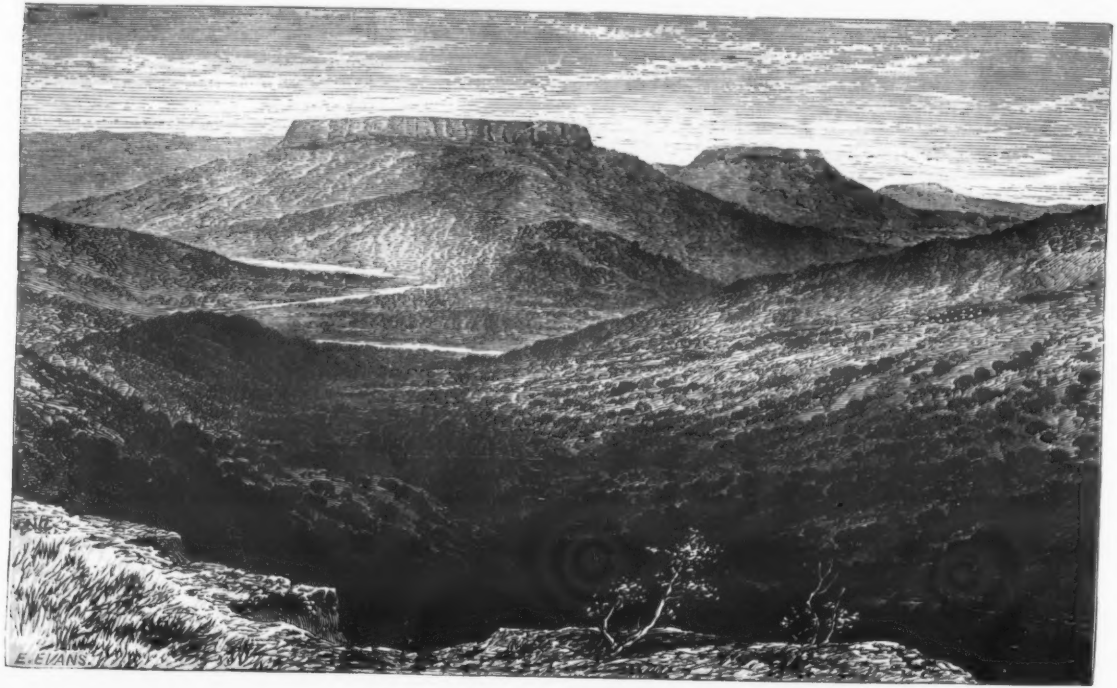
These conditions are provided in a very remarkable and interesting way in that portion of South-Eastern Africa in which the colony of Natal is placed, and hence Natal is a land of thunder and lightning.

This young colony of Great Britain stands on the south-eastern border of Africa, 800 miles beyond the Cape of Good Hope, and looking out on to the sunny Indian Ocean by a coast-line of about 150 miles long, that lies between the 29th and 32nd parallels of southern latitude. It is a strip of territory about one-third the size of England. Its landward frontier lies at a varying distance of from 120 to 160 miles from the sea. But this landward frontier is properly the broken edge of that central table-land of the African continent, whose surface is reared, in round numbers, some 6000 feet above the ocean. The strip of territory which constitutes the colony is in reality but a portion of the bevelled or sloping rim by

which the great continental table subsides to the sea; the edge where the upper pavement, or layer of veneer, has been chipped away, baring the foundation-substance of the structure.

This bevelled rim is accordingly not a smooth and evenly laid slope, but a rugged surface of valleys and hills subsiding gradually from the high mountain frontier to the sea in successive rises and falls, which wind, and twist, and branch in all conceivable directions. From one point of the mountain frontier, where it forms a salient angle towards the colony, there comes forth a subordinate but still very prominent ridge, which thenceforth becomes the key to the maze of hills, and to the configuration of the lower land. This ridge extends, as a great central system of highlands, quite across the middle of the colony, forming a mass of land which rises, at a distance of not more than seventy miles from the sea, above one mile high. From this central highland other derived ridges finger and fringe down to the sea, with distinct water-sheds and rivers lying between the several fingers. But northwards, and beyond the great highland, the land declines into a kind of broad basin, which is drained by a single large river system, and which is in reality a *coal-basin*. All these very interesting and, as we have presently to see, pertinent characteristics of the land, are pictorially represented in the accompanying little sketch, where the central highland is seen coming out from the Giant's Castle-point of the Drakenberg frontier, and fingering down to the sea, with the great rivers and smaller streams, from the Umvoti to the Ilovo, draining down between the fingers. And where the large upland basin of the single river, the Tugela, is also shown northward of the central highland.

Now, as the eye rests upon this little miniature representation of the physical configuration of Natal, it will be very easy to realize the fact that, broken and varied as the general surface of the country is everywhere, there is nevertheless a general rise, in advancing inland from the Indian Ocean, along a slope that has the comparatively steep gradient of one in seventy, until the culminating central highland is passed. It is very much indeed as if Ben Nevis were made one-fifth higher than it is, and stretched out across the entire breadths of the counties of Oxford, Buckinghamshire, and Hertford; and were then sloped and ribbed away to the shores of the English Channel by an irregular succession of abrupt and broken falls. Such is the country which lies on the shore of the Indian Ocean, almost under the blaze of a tropical sun, and which, for most beneficent reasons and uses, is made into a manufactory of thunder-storms.



The Valley of the River Umgeni from Table Mountain.

It has been already premised that the first great requisite—the prime raw material which has to be supplied in large abundance, in this manufacture—is invisible vapour capable of being turned, at a minute's notice, into copious deposits of palpable mist and water. Now, this raw material is drawn in the greatest abundance from a never-failing source close at hand, and the business of the supply is managed in this way. The sun, shining down day after day on the broad slope of land which is inclined from the mountains to the sea, heats the air in that position very considerably, and this most especially in the season of summer, when the sunshine falls most directly on the ground, and when the days are the longest. The heated air necessarily acquires a strong tendency to rise along the slope. In other words, it is *driven in* by the superior pressure of the cooler and heavier air resting over the less heated sea. A strong and steady breeze thus blows from the sea up over the land. This tendency to a sea-breeze is also confirmed and increased, for a considerable portion of the year by the further fact that in these latitudes of the earth the great trade-wind movement to some degree affects the air, and that the general set of the southern trade-wind is in the same direction. The characteristic streams of cumulus cloud, which so remarkably distinguish the trade-wind sky over the broad ocean, may at certain periods of the year, when the southern trade-wind stretches farthest to the south, be seen sweeping in from the ocean over the green hills of Natal.

From the combined operation of these two strong influences, it happens that, four times out of five, when the direction of the wind is noted, it is found to be from the south-east, streaming in from the broad sea to the land. This frequent and prevalent sea-breeze is most steady in the middle and after part of the day, and most interrupted after the middle of the night, when the air over the land is least affected by the warmth of the sunshine. Now, a sea-breeze is notoriously a moist one. It comes in from the ocean naturally laden with the heaviest load of moisture that it is able to sustain in the circumstances. If it arrived with its burthen at a spot where it had immediately to encounter diminished temperature on striking the land, its burthen would appear as visible or palpable mist and rain. In the instance under consideration, this is not the case. It arrives at land that is, at least during the day, warmer than the sea. Consequently, no visible moisture is immediately thrown down. The air, as it moves along up over the land, for a long time still sustains its heavy load of vapour in a transparent

and invisible condition. At length, however, as it moves along over the heated ground, it becomes so warm that its upward movement is largely accelerated, and it takes to mounting somewhat after the fashion of the strong up-cast in the shaft of a heated chimney, or of the ascent of a very light balloon. In the higher regions of the atmosphere, it finds itself suddenly freed from a considerable portion of the overlying weight which it has previously had to bear. Freed from this weight it expands, and by the mere act of expansion is cooled and chilled. Very often this, too, occurs simultaneously with the decline of the afternoon's sun, and the withdrawal of the direct warmth of the sunshine. The result is the sudden and very copious condensation of invisible vapour, in these high regions of the air, into tangible mist and moisture. The sky is suddenly piled up with dense clouds, which grow heavier and thicker until rain streams from the black canopy to the ground, and the electrical force, which is set free by the act of condensation much too rapidly and abundantly to be able to be quietly dissipated, flashes forth in brilliant lightning.

Such is the material and mechanical process adopted in the manufacture of the thunder-storm.

The operation of this remarkable proceeding is so constant and steady in Natal, that, in a period of eight years' observation, there were 408 thunder-storms in the city of Maritzburg; or, to speak more exactly, 408 days on which thunder-storms occurred, for not unfrequently there are several storms following at brief intervals on the same day. There were also ninety-six other days on which storms were prevailing within ten miles, so that lightning could be seen or thunder heard from the city. This, however, it must be understood, does not really furnish a full and sufficient tally of the prevalence of the thunder-storm, for the phenomenon is always of a fitful and restricted character. It sweeps along over a limited range of country, leaving intervals unvisited by its presence; so that it by no means follows that when any one spot, which is taken as a fixed point or station of observation, is without a storm for twenty-four hours, there are not places within fifty miles to the right or to the left where the storm is putting in a vigorous appearance. Very commonly distinct storms are raging simultaneously at different places, with void and fine weather intervals between. Taking this peculiarity into account, it is quite within the bounds of reasonable probability that there are storms somewhere in Natal almost daily during the hottest period of the year. If any one place, like the city of Maritzburg, is alone considered, the storm

may be confidently looked for at that period on each third afternoon upon an average.

The thunder-storm generally occurs in Natal immediately after a comparatively low barometer, when the mercury just begins to rise. The sea-breeze is, more or less, intermitted as it bursts, but sets in immediately afterwards with renewed energy and vigour. The clouds are first seen to gather about the tops of the highest hills as rolling caps of white and grey vapour, and then to extend themselves rapidly downwards and seawards. The storms observe earlier hours in the higher regions and among the mountains. At Maritzburg, 2000 feet above, and fifty-four miles from the sea, their usual time is from three or four in the afternoon to the early evening. A morning storm is almost an unknown occurrence, and night storms are comparatively rare.

At Maritzburg the storms nearly always sweep down from the higher hill-region lying towards the west or north-west; mist rolls down from the hills early in the afternoon, after a bright clear morning; the sun is concealed; light rain begins to fall; distant thunder is heard, which resounds at short intervals nearer and nearer; and then the tempest sweeps by, with an accompaniment of gusty wind and sheets of driving rain; the lightning flashing down, now here, now there, in broad vibrating streams, and the thunder at this time bursting with a crash, which, after a perceptible pause, "leaps" into a reverberating and subsiding roll. The actual fury of the storm is, however, very short-lived; a stream of blue or red lightning, five seconds before a rolling thunder-peal to the west; a blinding flash and a deafening crash almost simultaneous, and seemingly in the next garden or field; another lightning streak, ten seconds before a loud thunder-peal, quivering down in the dark cloud to the east, and the storm is gone on its rapid journey to the sea; and can be traced in its retreating track, after the sound of the thunder is lost, by the corruscations of lightning that illuminate the dark sky at repeated intervals. This is one of the very remarkable, and it may be added agreeable, traits of the tropical thunder-storm, its extremely lively movement. It is incapable of loitering or lingering; it is coming, and here, and gone, almost as soon as it has drawn the attention. It is a matter of the rarest occurrence to have it hang and brood over one place, as it sometimes does in England, for any protracted period. The writer has recorded, as an altogether exceptional instance, that on the 20th of October, 1863, there were six tolerably close discharges within ten minutes.

The rain, however, does not cease when the brunt of the storm

is passed; it continues to fall, but with less violence and vigour, commonly for two or three hours. It then stops, but the air does not clear; the sky remains shrouded in hanging mist until far into the night, when the veil is at last torn asunder in preparation for the morning sunshine. At that period the stars appear with a defined brilliancy and glory that they never wear upon any other occasion. It is no uncommon thing at such times in Maritzburg, which is 2000 feet above the sea-level, to see with the unaided eye the entire heavens, with the exception of the blank dark patch around the southern pole, literally scintillating with "star-dust," as the scattered hosts of seventh-magnitude stars advance into visibility through the clear, thin atmosphere.

The electric discharges of the thunder-storms of Natal are unquestionably of very high intensity. This is immediately expressed to the eye in a noteworthy way. The discharge is certainly, in the greater number of instances, from the over-burthened cloud to the earth; the track of bright light is continually seen ploughing its swift way down through the dark masses of the cloud until it is lost in the close neighbourhood of the ground; and there is this very remarkable peculiarity in the aspect of the track as it does so. It appears to the eye as a *broad ribbon* rather than an immeasurable line, as the electric discharge is generally seen in England. At the first glance it seems, too, to make its leap with more deliberation; it remains for a perceptible and appreciable instant graven upon the sky. More close and careful observation shows, however, that during this appreciable instant the luminous track is not steady. It quivers most distinctly, and it is this quivering that makes it apparently linger. This is certainly due to there being a rapid series of discharges following each other in succession along the same track. The intensely-charged cloud is relieved by successive leaps. The "ribbon-like" *breadth* of the electrical track is due to the very wide spaces of air that are involved in the transmission of the escaping electric force. This manifestation of very exalted intensity and great accumulation also gains instructive expression in another way. It frequently happens that animals out on the open pasture are killed by the electric discharge. Cattle, who are old stagers, cluster themselves together in severe storms, turning their heads inwards and hanging them down, and ranging their backs out like the spokes of a wheel. In this order of arrangement, many of the beasts are apt to be destroyed by one stroke. By reference to his notes of mischief effected by lightning in Natal, the writer finds that, on the 18th of October,

1863, eleven head of cattle belonging to a Kaffir were killed by a lightning discharge near the Noodsberg. On the 13th of December, 1863, five oxen were killed in the same way not far from Maritzburg. On the 21st of October, 1864, fourteen oxen, a cow, and a calf were killed near the Umgeni River. Sheep and other small animals are also sometimes sacrificed in numbers in more open order, while loosely scattered upon the pasture. On the 18th of December, 1862, seventeen calves were struck dead near the Mooi River. On the 27th of September, 1863, twenty-four goats, belonging to a Dutchman named Richter, were struck down, and sixteen of the number killed. On the 18th of October in the same year, five ewes and two lambs were killed near York. The common notion in cases of this kind is, that the animals are destroyed by the lightning passing from one to the other in succession, as the discharge of a Leyden jar passes through the successive links of a chain. The fact, however, is not so. The number of scattered animals destroyed is due *to the breadth of the space* occupied by the discharge. Close inspection of the place where scattered animals have been so killed commonly shows a brown surface, some yards in diameter, of seared grass, burned by the immediate stroke of the lightning. The animals are all but so many points in this broad area of completed contact. The grass is commonly fired by the discharge in the wild country, even when wetted by the rain. One of the chief dangers to which unprotected houses are exposed in the open country is that of the thatch, which is the common covering, being set fire to by the lightning. The Natal mail, which has just arrived in England, states that the house of the clerk of the resident magistrate of the Umzinto district, and also the house of one of the planters in a neighbouring locality, were burned down in this way on the last night of the last year. The Kaffir huts, which are altogether made of thatch and grass, and which are never protected by lightning-conductors of any kind, are consumed very frequently. Occasionally, after a severe thunder-storm, a rude lump of glass, formed from the fusion and vitrifaction of the siliceous cuticle and alkaline ingredients of the reed or thatch, and the blackened ground, are the only traces to show where a Kaffir hut had recently been standing.

Perhaps the next most noteworthy point connected with the lightning in Natal, after these remarkable indications of its inherent energy and power, is the brilliancy and diversity of the colour that it assumes. This is most vividly seen in the broad ribbon of the discharge. The quivering track of light is very commonly of a bright rose tint. But the rosy hue often passes into delicate pink,

or pale blue, or lilac, or it is full orange or purple. Occasionally the discharge is a very pure white, and sometimes of a curious dull leaden hue. There is, indeed, scarcely any gem in the jeweller's repertory that the Natal lightning does not seem capable of copying in the matter of lustre and colour. The beauty of the chromatic display is often enhanced, as the storm drifts away, by the hieroglyphics of coloured light that are traced in the dark masses of the retiring clouds, at each discharge. At one time a large coronal of fire leaps out of the rolling mist, and scatters outwardly radiating lines in all directions. At another time the radiant figure more nearly resembles the aspect which is produced in starred glass; it looks as if a brittle cloud was suddenly cracked and starred with little fissures of fire. Occasionally the fire-track leaps along in grotesque curves, or bent bows with strings, fringes, and offshoots running therefrom in every conceivable direction. Very often, indeed, the lines pass horizontally to and fro, shooting backwards and forwards like the weaver's shuttle, immediately above the flat tops of remote table-mountains, that in a clear day would be visible on the distant horizon, but in the darkness of the storm, or of the evening, only have their presence indicated by these "lightning shuttles" at work in the woof of their cloud table-cloth. Occasionally the perpendicular walls are battlemented with electric fire. There is a very beautiful and characteristic table-mountain of this class, visible, at about twelve miles distance, from the city of Maritzburg, which lies in the line of the retreating storms, and which is constantly the scene of these natural and most beautiful pyrotechnic displays.

The South African table mountains are the frequent cause of very magnificent stretches of bold and wild scenery, and legitimately find a passing notice in this place, on account of the sympathy that seems to exist between their upreared blocks and "cloud table-cloths" and the powers that manufacture and mould the lightning. The accompanying representation (see Plate) is introduced because it gives a very exact and truthful notion of the general character and form of these mountains, and of the grandeur of the scenery that surrounds them. The mountain of this plate is not that which is seen from Maritzburg; but it is the next mountain in the series. The view is one that is contemplated from the shoulder of the Maritzburg table-mountain, and is indeed the engraver's reproduction of a photograph made from that spot by the writer. It comprises the valley of the Umgeni, which river is seen like a silver thread winding for miles, hundreds of feet below, as it

comes down from a spot where it leaps a mighty precipice of columnar basalt in a cascade twice the height of Niagara.

The foliage clothing the sides and bottoms of the valley is composed principally of flat-topped thorny mimosas, and the small circular object on the hill side to the right is a native village, or kraal; a circular cluster of the straw, beehive-like huts which are constructed as dwelling-places by the Kaffirs. The table-mountain, like all the rest of its class, is a grand, ribbed pedestal of granite, or gneiss, many hundred feet high, bearing aloft upon its summit a thick, horizontal block or slab of old sandstone, with bare and precipitous sides. The ribs and buttresses of the base are all masked in vegetation, and verdant with grass and shrubs. But the top of the table is naked rock, scored by the horizontal shelf-like edges of the successive layers of the sandstone, and shining forth above the green base in the brightest and boldest relief when it is illuminated by the low glancing rays of the evening sun. The valley in the engraving inadequately represents the brilliant sinuous silver line of the river, but otherwise renders very well indeed the character of the beautiful hollows that lie between these fine old isolated flat-topped mountains of Southern Africa. These characteristic masses are of common occurrence in all directions, and seem really to be but so many remnants of the old broadly-spread pavement which was once evenly continuous with the great central table-land of the continent. In ages long gone by, the sanded floor of a yet older sea seems to have been lifted to form the dry continent of Africa. At some subsequent time the reared pavement of this continent was shattered and broken into several fragments, by yawning chasms, opened by the earthquake. At the present day some of these several fragments still stand, mountain-monuments of the past convulsion, reared upon their enduring pedestals. The chasms, however, have been widened into broad rolling basins, and grooves moulded in granite and trap. What has become then of the sandstone slabs that once overlaid these intervals in continuation of the tops of the table mountains? No one can say. All trace of the old ruin, saving these table mountain-monuments and the intervening chaos of bared granite and trap, has entirely disappeared. The thoughtful observer who rides through the valleys, and measures their vast spaces simultaneously with his eye and by the time occupied in traversing them, can, however, scarcely escape from the conviction that the lost slabs of the old pavement have been all sucked down into the sea of molten rock that welled up through the chasms of the convulsion, to be there fused and "metamor-

phosed" into the crystalline, and trappæan, and slaty substances that now form the floors and sides of the "unpavemented" hollows and intervals.

The brilliant colours of the Natal lightning bring forcibly to the mind of the thoughtful observer the way in which modern science explains the production of "electric fire." The electricians hold that the light of the electric discharge is entirely due to the absorption of minute metallic particles present in the vapours of the air, and that the differences of colour depend on the diversity of the substances that are thus rendered incandescent by the transmission of the high electric tenison. The resemblance of these Natal lightnings to the brilliant lights developed by the combustion of metals, immediately strikes the eye. The radiant tracks that shoot out in the clouds over the mountain tops most curiously reproduce in large the effect that is witnessed in miniature, when a strong electric spark is taken upon a ball coated with gold-leaf or copper-leaf. Singular instances occasionally occur in Natal, as elsewhere, in illustration of the idiosyncrasy of the lightning to make free with the metallic principles which it needs for the sustenance of its flames. The writer met with one case in which some picture frames were nearly stripped of their gilding by a lightning-stroke, that shattered the house containing them, without further mischief being done to the pictures. Instances of this character immediately recall to the memory the anecdote recorded by M. de la Rive, of the lady's arm which was robbed of its gold bracelet by a flash of lightning, as the lady closed a casement, without any serious mischief being inflicted upon the arm itself.

There is yet one other most beautiful form in which electric light is commonly seen late in the Natal evenings. As the thunder-storm drifts away, the edges of the retreating clouds are illuminated by the play of the electric discharges which are in process of running to and fro where the immediate track of the discharge is veiled from the eye by the intervening masses of thick vapour. The effect of this "distant play" of the lightning is inconceivably grand. No effect of "sheet lightning" encountered in England can be even compared with it. The dark broken edges of the cloud are brought out in the most varied and fantastic forms, and in the most intense clearness, by a vista of coloured glow that seems, for the instant, to open out glimpses of a deep infinity beyond. At times, these Aurora-like glows may be seen flashing out from beneath the broad cloud-canopy that covers the higher heavens, in all parts of the horizon in rapid succession, as if "repeating signals" to each other,

and this splendid display is apt occasionally to continue for a long period of time, possibly stretching to hours. The writer has noted these "sheet-lightning signals" being thrown out from six distinct points of the horizon at once, and he has counted fifty-six flashes in the minute. The effect is no doubt produced by reflection from cloud-vapour of the light emanating from the small discharges which are constantly at work equalizing the disturbed electric tensions of different portions of the storm canopy, and which constitute the "coronal" and "radiant" and "starred glass" fire-tracings already alluded to, when the actual tracks of the discharges themselves are in sight.

It will be readily understood, from the explanation which has been now given of the "manufacture of the thunder-storm" in this district of South-Eastern Africa, that the effect is most frequently and most constantly produced, in the hottest period of the year, when the great operative who works the process—the sun—is in most energetic activity. Forty-seven thunder-storms occur at Maritzburg, on the average, in the eight months that lie between September and April. But only four occur in the four months that lie between May and August. At least eight storms occur in each of the midsummer months of December and January. In the winter months, the same series of aerial movements go on, but with far inferior energy. The clouds get piled up round and over the higher hills in the late afternoon, and silent lightnings may be seen playing among them. But the disturbance only on very rare occasions gathers head into the rapid and copious condensation which is essential to the development of the actual tempest. This has a very remarkable and important effect upon the climate of Natal. The winter is a period of genial, almost uninterrupted sunshine, and the temperature is kept agreeably high through that season. The mean temperature of the six winter months at Maritzburg is 60° of Fahrenheit's scale, while the summer is a period of no less frequent cloud and abundant moisture and evaporation. In consequence of the constant drawing of the afternoon cloud-screens, and the constant sprinkling of the heated land, and the cooling evaporation which naturally follows from the sprinkling, the mean temperature of the six summer months at Maritzburg is only 69°.

The more important benefit worked by these thunder-storms is, however, the energetic vegetation which is called forth in consequence of this most auspicious combination of punctual periodic watering with the nearly tropical summer sunshine. The land is like a well-kept conservatory, where, while a steady bottom-heat is

maintained, the rose of the watering-pot is turned by the gardener's careful hand now on this side, and now on that, so that the soil is always drenched with the life-carrying stream. On this account, the entire country is literally clothed with verdure, from the sands of the sea to the tops of the mountains, during the greater part of the year. There is, however, so much of deep interest to be told of the twin-sister of the lightning and thunder—namely, the rain-fall; the direct aqueous condensation and deposit which accompanies, and indeed causes, the electrical manifestation—in Natal, that the subject cannot be touched upon at the end of a paper. Neither can the curious illustrations of the mechanical effect of the lightning-discharge, and the protective powers of the lightning-rod, which this "favourite haunt and home" of the meteor affords, be now spoken of as they might have been had space and opportunity allowed. These are both subjects that must wait for another occasion.

ASTRONOMICAL NOTES FOR MAY.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

VENUS and Saturn are this month, also, the only planets suitable for evening observation.

VENUS is at her greatest elongation on the morning of May 7th, at 11h. 32m., and is afterwards horned. As she is still approaching the Earth, she will constantly increase in apparent brilliancy. On the first day she sets at 11h. 47m.; but as her path in the heavens begins after the 6th to carry her in a southerly direction, she will shortly afterwards set rather earlier, the time on the last day of the month being 11h. 26m. Early in the month she will pass from the constellation Taurus into Gemini, and continue there until June. About the 28th of May, she will pass between 3° and 4° to the south of Pollux. In the last evenings of the month, therefore, Castor and Pollux will form a very beautiful group with her, and will set off still more conspicuously her surpassing brilliancy.

SATURN rises on the first day at 9h. 6m. in the evening, and on the last day at 6h. 56m. During the first half of the month he will be very near the close double star ν Scorpii; towards the end of it he will approach a position nearly due north by about 2° of ω^1 and ω^2 Scorpii, two stars each of the 4½ magnitude, situated within less

than half a degree of each other. As we mentioned last month, the occasion is in other respects very favourable for observing Saturn's rings; but it is unfortunate that the planet is low in the heavens, its meridian altitude being, in fact, only about 20°.

Occultations of Stars by the Moon.—Two only of these phenomena that are of any importance will occur this month in the evening. They are:—

DAY.	NAME OF STAR.	M.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
May 4	β Virginis	5	9 7	56	10 21	236
„ 27	18 Leonis	6	10 31	99	11 25	304

It may here be desirable again to call attention to the fact which was mentioned in the April number of the Student, under the head "Astronomical Items," that Mr. Marth, through Mr. Newall, brought under the notice of the Royal Astronomical Society at its meeting in March, the probability, if the weather be favourable, of the occultation of the bright star Aldebaran on the *afternoon* of May 22 being observable. That phenomenon is not noticed in the "Nautical Almanac," from its occurring only about twelve hours after the New Moon. But as Aldebaran is a star well suited for daylight observation, and will be about 8° distant from the Sun, there appears sufficient reason for thinking it possible to make the observation with a good telescope, if the sky be free from both cloud and haze. At Greenwich the times of disappearance and reappearance will be 6h. 26m. and 7h. 13m. respectively; the angles at the Moon's centre made at those times by lines drawn to her north point and to the star, 55° and 295°. The reappearance will take place near the middle of the illuminated crescent, the breadth of which will there be about ten seconds of arc.

The Moon.—We give, as last month, a table of the phases of the Moon, and the more remarkable objects which will be under or near the terminator on some of the evenings.

May 1. Mare Imbrium, Copernicus, Bullialdus.
„ 3. Kepler, Mare Humorum, Gassendi.
„ 4. Aristarchus, Schickhard.
„ 5. Galileo, Hevel, Grimaldi, Riccioli.
„ 6. Full Moon at 6h. 37m. P.M.
„ 7, 8. Mare Crisium, Langrenius.

May 9. Mare Fœcunditatis.
„ 10. Mare Tranquillitatis.
„ 14. Last Quarter at 5h. 15m. P.M.
„ 22. New Moon at 6h. 36m. A.M.
„ 24. Mare Crisium.
„ 25. Posidonius, Mare Fœcunditatis, Theophilus.
„ 26. Mare Serenitatis, Linné, Plinius.
„ 27. Aristippus, Autolycus, Hipparchus, etc., coming into view.
„ 28. First Quarter at 11h. 42m. P.M. Archimedes, Ptolemæus, etc.
„ 29. Plato, Eratosthenes, Mare Nubium.
„ 30. Mare Imbrium, Copernicus.
„ 31. Reinhold, Bullialdus.

Orbit of 70 Ophiuchi.—It is well known how interesting has been the whole subject of double stars ever since Sir William Herschel, about the beginning of the present century, published the results of his observations of a considerable number of them, containing the remarkable discovery of the existence of physically-connected or binary stars. He was first led to the systematic observation of the mutual distances and angles of position of double stars, by the hope of being enabled to detect thereby the existence and amount of their annual parallax and actual distance in the way in which the matter has since, in the hands first of Bessel and afterwards of others, been brought in several instances to a successful issue. But the great number of stars which were found to be in extremely close proximity, was itself sufficient to suggest some connection more intimate than mere casual or optical juxtaposition; and after carrying on his measures for some time, Herschel found his attention carried off from the original subject of inquiry by phenomena of a character then unexpected, but with which we are now familiar. These consist in changes of position which indicate the orbital motion of one star of the double star round the other, that is, of one *sun* round another *sun*; and the orbits of several of them have more recently been determined with a greater or less degree of accuracy, showing that the Newtonian law of gravitation obtains in these systems as well as in our own. A very elaborate investigation of that of the double star 70 or *p* Ophiuchi (the components of which are of the 4½ and 7th magnitudes respectively) has just been published in the "Astronomische Nachrichten," by Dr. Schur. It is the more interesting because the annual parallax, and therefore distance of the star, are approximately known. Its right ascension is 17h. 59m.; north polar distance, 87° 28′. Its duplicity

was discovered by Herschel in the year 1779. Struve, whose labours, first at Dorpat and afterwards at Pulkowa, placed him at the head of this department of astronomy, and who distributed the double stars into classes according to the proximity of the components, commencing with the nearest as the first class, placed this in the fourth class, that is, that of stars whose mutual distance is between 4″ and 8″, it being, in fact, in this case about 5″.

Sir William Herschel observed this remarkable double star from 1779 until 1804; after that time it was not observed till Struve commenced to devote attention to it in the year 1819. The companion star had in the mean time, in its revolution round its primary, passed (in 1808) its perihelion. Since that time it has been observed a great number of times by Sir John Herschel, South, Dawes, Bessel, Otto Struve, Mädler, Dembowski, and others. Nevertheless, the determination of its orbit has given calculators much trouble and perplexity. Doubts were even entertained of its obedience to the Newtonian law, and Mädler called the determination of the orbit an *experimentum crucis*.

The first determination was made by Professor Encke. He followed a method of his own, which in principle was similar to that of M. Savary (the first who determined, in the case of ξ Ursæ Majoris, the orbit of a binary star), but was in some respects an improvement upon it. The resulting period of revolution was about seventy-four years. The observations made use of extended to the year 1823. Whilst those observations were well represented by the orbit thus determined, later ones by Struve at Dorpat and by Bessel at Königsberg appeared to be quite irreconcilable with it, the former in the distances, the latter in the position-angles. An attempt to obtain a better orbit by uniting these with the early ones of W. Herschel, led to discordances equally inexplicable with the observations of J. Herschel and South. The principal cause of these discordances appears to be the attributing too much weight to the early observations, when the methods were much less perfect.

Sir John Herschel and Mädler afterwards made a determination of the orbit, each finding the period to be a little more than eighty years. The former employed a graphical method, by which the distances only were used to determine the dimensions of the orbit, and all the other elements were deduced from the position-angles. As might be expected, the latter were well represented; but the agreement of the distances was not so good, and the discordances seemed to show that almost all the distances measured by the Dorpat refractor were too small—indicating that the discordances were probably due to the method of observation. Mädler, in the

endeavour to reconcile all the observations, made three determinations of the orbit, but at last concluded that either (1) the motion in this binary system does not follow the Newtonian law, or (2) the centres of the images of the stars as seen by us are not the centres of gravity of their masses. He considered the latter the more probable hypothesis, and adduced the analogous cases of Sirius and Procyon, in both of which Bessel had conjectured the existence of a disturbing body.

Mr. E. B. Powell also made a determination of the orbit, with a period of ninety-eight years: but the distances observed afterwards showed a considerable deviation from those obtained from his orbit. Yvon Villarceau also calculated one according to a very elegant method of his own, making the period ninety-three years; but although it well represented the observations after 1823, comparison with those anterior to that date showed the necessity of an alteration in it.

Captain Jacob executed two determinations, the second of which is interesting from the attempt made in it to explain the anomalies in the motion of 70 Ophiuchi by assuming, in accordance with the suggestion of Mädler, the existence of a third body in its system—an opaque and invisible body in the neighbourhood of the fainter of the two stars disturbing the motions of both. However ingenious is this attempt (and a similar cause is now generally admitted to account for the irregularities in the proper motion of Sirius), yet Dr. Schur states that it appears to him that the anomalies may be quite as easily removed by a small change in the elements; and, moreover, they are too small to draw from them conclusions of any certainty with regard to the existence, much less the elements, of a third disturbing body.

In the year 1855, Professor Klinkerfues published a new determination of the orbit, which well represented all the observations up to 1852 (which were employed in the investigation) on the supposition of an ellipse. The only remarkable discordance was in the position-angles about 1832, which seemed to indicate the necessity of a diminution in his periodic time, which amounted to nearly ninety-six years. Although the earlier doubts about the possibility of thus reconciling with sufficient accuracy all the observations on this hypothesis were thus satisfactorily removed, yet Dr. Schur, in the paper before us, says that he considered it desirable again to repeat the process, both on account of the discordance referred to, and because, since the year 1852, a great number of good observations had been made by Dembowski, Dawes, Otto Struve, Mädler, and others: moreover, the passage of the companion star through its aphelion in 1856, gave hopes of thereby determining the dimen-

sions of the orbit with greater certainty. He has, therefore, furnished another determination, from an elaborate discussion of all the materials, making use of the method of Sir John Herschel with some modifications. The orbit he finally determined is in very close agreement with all the observations up to the present time, the only discordance of any amount being shown by those made between 1823 and 1827, some constant or similar error in which was probably the principal cause of the difficulty found by earlier calculators in reconciling all the observations, when there were, besides those, a much smaller number available than at present for the construction of an orbit. Of the elements definitively adopted by Schur, the time of perihelion passage is 1808·79; semi-major axis 4″·9063; eccentricity 0·4915; periodic time 94·37 years.

It was now possible to determine the actual mass of this double star, in terms of that of the Sun. For Krüger had, from the observations with the Bonn heliometer, in the years 1858—1862, obtained a measurement of its annual parallax, finding it to be 0″·162, with a probable error of 0″·0071, which gave a distance of the star from the solar system amounting to 1,273,000 times that of the Earth from the Sun; that is, one which light would occupy 20·1 years in traversing. Hence Schur finds that the mean distance of the two stars from each other is about 30·3 radii of the Earth's orbit, and that their mass is about 3·12 times that of the central body of our system.

Brorsen's Comet.—The return of this comet to perihelion leads us to devote a few words to its previous history. It was discovered at Kiel by Brorsen, then a student there, on February 26, 1846, at eight o'clock in the evening, near η Piscium, and telescopic. Two days afterwards it was in consequence observed by Petersen at Altona, and by Rümker at Hamburg. At first it was suspected that it might be the same with one which had been detected by De Vico on February 20; but comparison of the place observed by the latter with one deduced from elements of Brorsen's comet, which had been calculated by Petersen, showed that they were really different comets. And, accordingly, Brorsen himself found the other also on March 8, and it was afterwards observed by other persons. Later in the month, elliptic elements of Brorsen's comet were calculated by Dr. Brünnow and by Mr. Hind, and the period shown to be about five and a half years. It had passed its perihelion on February 25, or one day before its discovery. By April 22 it had become, according to Encke, "such an extremely faint and diffused nebulous patch, that very faint stars near it prevented its being seen."

The next perihelion passage occurred in September, 1851; but at that return the comet was not seen, owing to its unfavourable position with respect to the Sun.

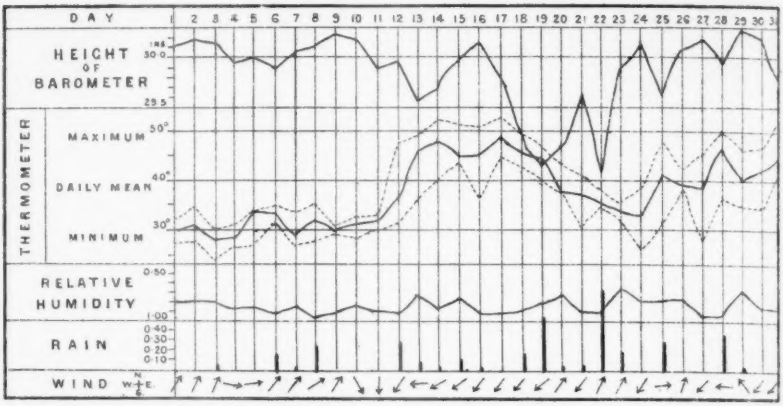
At the next return, in 1857, it was first detected by Dr. Bruhns on March 18. Pope showed that the comet thus discovered was identical with Brorsen's of 1846, and computed elements of the orbit. This comet passed its perihelion on March 29. In appearance it resembled a round nebula of about 2′ in diameter, and was a little condensed towards the centre, but very faint. It was, however, brighter than when observed in 1846, and about the middle of April the centre was much condensed, though there was no defined nucleus; it never showed any trace of a tail. Prof. d'Arrest showed that the comet had been thrown into its present orbit in 1842, in consequence of a very near approach to the planet Jupiter in the spring of that year; previous to which its perihelion distance was considerably greater. Its history, therefore, presents a remarkable analogy to that of Lexell's comet, in which, however, the alteration of path was much greater.

At the next return to perihelion, in the autumn of 1862, Brorsen's comet escaped observation, as in the year 1851. As the forthcoming perihelion passage at the time we write, will be past when these pages meet the reader's eye since it occurs towards the end of April, it is possible that he will then know more of the comet than we can now acquaint him with; but the foregoing particulars concerning its previous history may not be uninteresting.

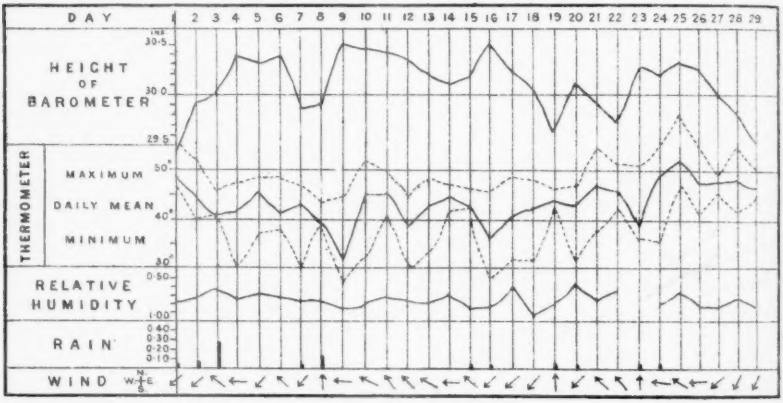
Addendum.—Since the above was written, an ephemeris of the comet has been published by Prof. Bruhns of Leipzig. He fixes its perihelion passage for April 18, about midnight. But the comet will continue to approach the Earth until nearly the end of May. It is also rapidly attaining a greater northern declination. The place will be on May 1, R.A. 4h. 53m., N.P.D. 53° 56′; on May 6, R.A. 5h. 28m., N.P.D. 49° 27′; on May 11, R.A. 6h. 7m., N.P.D. 45° 35′; and on May 16, R.A. 6h. 52m., N.P.D. 42° 36′. Its course in the heavens will carry it during that time from the constellation Auriga (being very near β Aurigæ on May 9), into that of Lynx, which consists almost entirely of small stars. Even at the beginning of the month, it will pass the meridian between two and three o'clock in the afternoon, and will continue above the horizon until midnight: during the latter part of the month it will not set at all. The Full Moon occurring on the 6th, will probably make the observation for some days before and after that date extremely difficult, if not impossible.

DIAGRAMS, REPRESENTING THE METEOROLOGICAL VARIATIONS AT THE KEW OBSERVATORY.

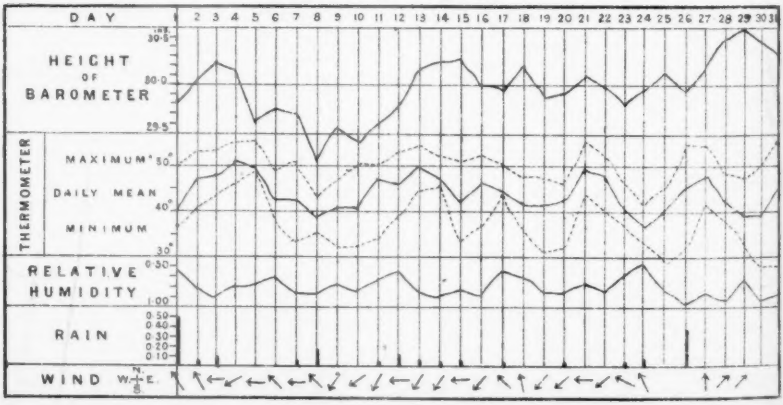
JANUARY 1868.



FEBRUARY 1868.



MARCH 1868.



RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LAT. 51° 28′ 6″. LONG. 0° 18′ 47″ W.

BY. G. M. WHIPPLE.

(*With three Plates.*)

IN the discussion of the present series of observations, we retain the form adopted in the last, and for the explanation of which we must refer the reader to the February number of the STUDENT.

JANUARY, 1868.

ATMOSPHERIC PRESSURE.—The mean barometric reading for the 1st inst. being 30·156, there was a steady downward movement to 29·880; on the 6th a gradual rise ensued, till the 9th, 30·235, after which the pressure steadily diminished up to noon on the 12th. A more rapid fall then commenced, which lasted till 8.30 A.M., on the 13th, the mean for that day being 29·539. The readings increased slowly to 30·140 on the 16th. At midnight on the 17th a fall began, lasting throughout the 18th, arriving at its lowest point at midnight on the 19th, the mean reading on the 19th being 29·053. The barometer rose to 29·606 on the 21st, falling again to 29·094 on the next day. At 4 P.M., on the 22nd, a continuous rise set in, which culminated 10 A.M., 24th. Afterwards, pressure diminished till midnight, the mean 24th was 30·135. After the 25th, we had increasing pressures to the 29th, 30·314, then diminishing to 29,872 on the 31st.

Mean height for the month = 29·890.

TEMPERATURE OF THE AIR.—The earlier part of the month was very cold, the temperature on the 1st being 30·0 and 28·2, 28·5 on the 3rd and 4th. The 5th and 6th were a few degrees warmer, but the thermometer was lower on the five succeeding days. After the 11th it rose rapidly to 48·5; the 14th, 15th, and 16th were a trifle colder, but the 17th was the warmest day during the month, the mean temperature being 49·0. At 8.45 A.M., on that day, a sudden fall of 5° was recorded, accompanied by a heavy shower of rain; a similar fall of 3°, also accompanied by rain, occurred just after midnight on the 18th. The readings then steadily diminished to 33·4 on the 24th, with the exception of an abrupt rise of 3° at 4.15 A.M., on the 22nd.

The temperature gradually rose to 8.20 P.M. on the 28th, after which a fall occurred, the mean on the 31st being 43·8°.

The highest maxima were—17th, 52·6°; 14th, 52·4°; and 31st, 52·3°. The lowest—3rd, 29·8°; 4th, 30·3°; and 9th, 30·4°.

The highest minima recorded were on the 15th and 17th, being 43·1° and 45·1°; and the lowest 23·8°, on the 3rd.

The extent of daily range was greatest on the 27th, 16·5°; 16·1° was registered on the 25th, and 15·8° on the 12th.

The smallest range was 1·3° on the 9th, on the 22nd it was 1·4°.

The mean temperature of the month was 37·8°.

The Relative Humidity of the air varied but slightly. The days on which the amount of vapour present in the atmosphere was least (complete saturation being 1·0), were the 23rd, ·68, and 29th, ·69; the days of greatest moisture were 8th, ·99, and 27th, ·96.

The monthly mean being 0·86.

Rainfall.—The amount of rain measured was as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
3.....	0·012* inch.	14.....	0·047 inch.	21.....	0·003 inch.
6.....	0·113* „	15.....	0·075 „	22.....	0·800 „
7.....	0·010* „	16.....	0·005 „	23.....	0·147 „
8.....	0·248* „	18.....	0·142 „	25.....	0·300 „
12.....	0·283 „	19.....	0·584 „	28.....	0·390 „
13.....	0·090 „	20.....	0·035 „	29.....	0·040 „

Those quantities marked * were melted snow.

Total fall during the month = 3·324 inches.

Wind.—The direction of the prevailing winds is shown by the small arrows occupying the lower part of the diagram.

It was:—

North—22nd, 23rd, and 26th.
North-East—1st, 2nd, 3rd, 6th, 7th, 8th, 9th, and 20th.
East—4th and 5th.
South-East—10th.
South—11th.
South-West—12th, 16th, 17th, 18th, 21st, and 24th.
West—13th, 14th, 19th, 25th, 27th, 28th, 30th, and 31st.
North-West—29th.

The velocity of the wind was generally moderate up till midnight on the 12th, but during the next two days it blew at a rate varying from twenty to thirty miles per hour. The 16th was calmer in the early morning, but after noon it blew more briskly, and continued rough till midnight on the 19th, the greatest velocity recorded being forty miles at 1 P.M. on the 18th. During the 20th, the direction veered from W. to S., to E., N., and W. again in the twenty-four hours. At 4.18 A.M. on the 22nd, a change of direction from N.E. to W. was recorded. The wind was very rough during the night of the 24th, its velocity being thirty-seven miles at midnight. At 2 A.M. of the 25th, it moderated to 11 miles, veering at the same time from S. to W.

February.

Atmospheric Pressure.—The barometer was falling at the end of the last month, and the mean for the 1st was 29·415. The fall continued till noon on the 2nd, after which it rose steadily to 30·374 on the 4th. The reading on the 7th was 29·894. At 3.30 A.M. on the 8th it ceased falling, and rising rapidly, gave 30·553 on the 9th.

The pressure steadily diminished to 30·121 on the 14th, increasing afterwards to 30·542 on the 16th. The mean for the 19th was 29·638; the next day gave 30·119, but a fall followed. At 10.30 P.M. on the 22nd, a sudden small rise of ·05 inch of the barometer was recorded, and through the 23rd it continued rising, giving a mean of 30·242. After reaching 30·344 on the 25th, it continuously fell, arriving at the minimum and turning at 7.15 P.M. on the 29th, that day's mean being 29·490.

Mean height for the month = 30·123 inches.

Temperature of the Air.—This was 48·2 on the 1st, and a steady diminution followed to 41·2 on the 4th, interrupted only by a rise from 10 P.M. to midnight on the 2nd. From 45·1 on the 5th, the thermometer went down to 31·7 on the 9th, that being the coldest day in the month. The 10th was milder, 44·9 being the mean. Falling through the night of the 11th, gave 39·6 the next day, again rising to 45·1 on the 14th. On the 15th the thermograph recorded a rapid fall of 5° at 2 P.M., the thermometer returning to its original position soon after.

The succeeding days were a little warmer. On the 22nd we find several strange fluctuations indicated. At 11 A.M. the thermometer fell 5° rising again after; this was repeated soon after noon, and a similar fall of 3° occurred at 10.30 P.M.

The 25th was the warmest day of the month, being 52·1. The temperature was a little lower after, being 46·3 on the 29th.

The days on which the highest maxima were recorded were 25th, 60·9, and 1st, 55·9, the lowest being 43·4 on the 8th.

Low minima were registered, 27·5 on the 9th, and 28·9 on 16th. The high minima were 25th, 47·8; 1st, 47·5.

The greatest daily range was 19·5, on the 10th. The least 2·3, on the 3rd.

The mean temperature for the month, 43·5.

Relative Humidity.—The days of comparative dryness were 17th and 22nd, the degrees of humidity being then ·63, and ·65.

The 18th was the day on which most aqueous vapour was present, being ·96.

The mean for the month, 0·75.

Rainfall.—This was very small in February, the recorded quantities being:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1.....	0·023 inch.	8.....	0·108 inch.	20.....	0·020 inch.
2.....	0·031 „	15.....	0·020 „	21.....	0·037 „
3.....	0·273 „	16.....	0·021 „	23.....	0·014 „
7.....	0·004 „	19.....	0·030 „	24.....	0·015 „

Giving a total fall of 0·596 inch for the month.

Wind.—The general direction of the wind was:—

North—8th, 19th, and 23rd.

South—19th, 28th, and 29th.

South-West—7th, 18th, and 20th.

West—1st, 2nd, 4th, 5th, 9th, 14th, 16th, 17th, 24th, 26th, and 27th.

North-West—3rd, 6th, 10th, 11th, 12th, 13th, 15th, 21st, 22nd, and 25th.

The velocity of the wind was very brisk on the 1st, being 49 miles per hour at 1 P.M.; it diminished gradually, nearly ceasing at 3 P.M. on the 2nd.

At the same time the direction changed from W. to S. At 10 P.M. it veered back to W., the velocity increasing to 30 miles, but went down again at 3.30 A.M. on the 3rd.

The night of the 6th was nearly calm, and the direction changed from W. to S.E.; 3.30 A.M. on the 8th recorded a veering from S.W. to N.W.

About noon on the 19th the wind, which had been blowing at 20 miles, dropped to 5, the direction changing from S. to N. After a short time the velocity went up to 20, and on the 20th, 5 A.M., the direction went back to S.W. During the next night the velocity was 25 miles, calming down at 5 A.M. on 21st. The rate was more than 30 miles per hour on the 29th, up to 7 P.M., when it diminished to 10, direction changing from S. to N.W.

March.

Atmospheric Pressure.—From 29·851 on the 1st, the barometer rose to 30·220 on the 3rd. At noon on the 4th it began to fall steadily, reducing the next day's mean to 29·640.

After noon on the 7th, the pressure rapidly diminished, until the 8th, 5.15 A.M., when an instantaneous rise of 0·1 inch occurred, after this the increase of pressure was continuous till next day. The mean for the 8th, was the lowest during the month, 29·143.

Rising readings continued up to 30·224 on the 15th; the 16th, and the 17th were a little lower, but the 18th was again 30·210.

The variation was small for some days succeeding. At 11.30 P.M. on the 22nd a sudden rise of about 0·07 inch was recorded.

From 29·956, on the 26th, the barometer gradually went up to 30·578, on the 29th, this being the highest daily mean during the month, a fall followed to 30·382 on the 31st.

The mean height of the barometer for the month was 29·982.

Temperature of the Air.—This was 39·9 on the 1st, and was followed by increasing temperatures up to 50·8° on the 4th, a noticeable feature being a rise of 2° recorded at 3 P.M. on the 2nd.

At 3 P.M. on the 6th, the thermometer fell 4°, rising gradually after to its former position. The 8th was characterized by two sudden falls, the one of 6°, recorded at 5.20, and followed by steady decrease of temperature, the other of 4°, at noon, succeeded by a rise, the mean for the day being 39·0°. After the 10th, the days were somewhat warmer, reaching 50·4° on the 13th, this was the highest daily mean for the month, the temperature on the 21st being 50·1°. The thermometer was unusually stationary all through the 22nd up to 11.30 P.M., when it suddenly dropped 6°. On the 23rd it was very fluctuating, and the next day was the lowest mean in the month 37·3°. The readings increased to 48·1° on the 27th, coming down to 40·0° on the 29th and 30th, rose again to 45·4° on the 31st.

The highest maximum temperature registered during the month was on the 31st, 57·7°; the lowest, 42·3°, on the 24th.

The highest minimum temperature recorded was 48·5°, on the 5th, the lowest being that for the 30th, 28·5°.

The largest daily range was that for the 31st, 29·0°; the smallest, 5·9°, on the 17th, and the mean for the month 14·0°.

The mean temperature of the same period was 44·3°.

Relative Humidity.—This month was generally drier than the preceding two. The degree of moisture present in the air being 0·52 on the 24th, therefore the driest day in the month. The proportion was 0·61 on the 1st and 17th.

The day of greatest humidity was the 26th, 0·98.

The mean for the month = 0·79 inches.

Rainfall.—There were no large amounts of rain recorded during March, the quantities measured being as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1.....	0·510 inch.	11.....	0·017 inch.	20.....	0·015 inch.
2.....	0·013 „	12.....	0·083 „	21.....	0·003 „
3.....	0·050 „	13.....	0·060 „	23.....	0·015 „
6.....	0·008 „	14.....	0·020 „	24.....	0·025 „
7.....	0·010 „	15.....	0·025 „	26.....	0·405 „
8.....	0·180 „	17.....	0·025 „		

Giving a total fall in the month of 1·464 inches.

Wind.—The general direction was:—

North—18th and 27th.
North-East—28th and 29th.
South—10th, 11th, and 30th.
South-West—4th, 9th, 13th, 14th, 16th, 19th, and 31st.
West—3rd, 5th, 7th, 12th, 15th, 20th, 21st, and 22nd.
North-West—1st, 2nd, 6th, 8th, 17th, 23rd, and 24th.

The 8th was noticeable for a change of direction and force, which occurred at 5.20 A.M., the wind veering from S.W. to N.W. The wind was very gentle on the 15th, being nearly calm from 5.30 to 8 P.M. At 8 A.M. on the 16th the velocity increased, attaining the rate of from twenty-five to thirty miles per hour, up to 5 A.M. on the 17th, then it changed from S.W. to N.W., and went down. The night of the 18th was calm.

At 11.30 P.M. on the 22nd the direction changed from S.W. to N., and the velocity diminished considerably.

At 1.20 and 3 P.M. on the 23rd, strong northerly gusts were recorded, the general direction at the time being W. During the 25th the wind gradually veered from N. by W. to S., returning again to N.W. the next day.

ON THE NEW THEORIES IN CHEMISTRY.

BY F. S. BARFF, M.A. CANTAB., F.C.S.,

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No. III.

WHEN compounds are brought into contact, an interchange of their constituents frequently takes place, but contact is necessary to effect this. Heat produces change in the state of substances; when this change continues only as long as the body remains under the influence of heat, its effect is called physical, but when it causes a permanent alteration in the constitution of the substance, the effect is chemical.* For example, iron when heated increases in bulk and acquires other properties different from what it had when cold; it can combine with chlorine, for example, but when it is allowed to cool it returns to its original dimensions, and assumes its original inertness; but when oxalic acid is heated it breaks up into three other compounds, and if these be collected and examined, by passing them through chloride of calcium and caustic soda, and collecting the residual gas, the chloride of calcium will retain water, the soda carbonic acid, and the vessel in which the residue is collected will contain carbonic oxide, bodies formed by a new arrangement of the elements which compose oxalic acid—

$$C_2H_2O_4 = H_2O + CO_2 + CO.$$

Heat has permanently altered the original constitution of the oxalic acid, and its effect is called chemical. It must here be understood that oxalic acid is not supposed to contain its elements in the form of water, carbonic acid, and carbonic oxide, but that when the compound oxalic acid is destroyed by heat, its elements, which were before so arranged as to form that acid, under the strong reagent, are separated, and eventually form the three products mentioned.

* Some metals, for example lead, after being heated, do not return to the same size when cool; an instance of this is seen in the buckling of sinks. This is a physical, not a chemical effect.

It is difficult, if not impossible to draw a clear line of demarcation between the chemical and physical effects produced by heat, or to define accurately in what they consist; or to state where the one begins or the other ends. If phosphorus be heated out of contact with air, or in an atmosphere which contains nothing which can react on it so as to form a compound, such as carbonic acid, and if it be kept for some time at a temperature of about 240° C., it will be changed into a body having a different appearance, and, to a certain extent, different chemical properties. It is, before being heated, a waxy-looking mass, which slowly gives off white fumes of phosphoric acid when exposed to the air, and emits light, is extremely energetic in its action, soluble in bisulphide of carbon, and decomposes a solution of sulphate of copper; after the application of heat it becomes a red amorphous powder, it is not oxidised on exposure to air, nor does it emit light, it is insoluble in bisulphide of carbon, and does not precipitate copper from solutions of its salts. Here heat alone has effected a change which cannot be called simply physical; it is, as far as it goes, chemical, nor is it in any way analogous to the action of heat on compounds, which it breaks up or destroys. The change may be called a molecular re-arrangement, but if so, the expression implies something beyond the ordinary meaning of the words; neither is it analogous to the effect which heat produces on the oxide or sulphide of mercury; for in these the change is not of chemical properties, but one, which, till it is better understood, may be called molecular. There are still other differences between these two kinds of phosphorus which cannot be strictly called physical. The heat produced by the combustion of clear phosphorus is greater than that produced by the other, in the proportion of 1 : 1·15. The specific heat of the red variety is 0·17, and that of clear phosphorus 0·1887. But if red phosphorus be heated to a temperature beyond 240° C., it gradually becomes reconverted into common phosphorus, and distils over as such. Heat, therefore, produces more than what are called physical effects in simple bodies, and is one of the most important agents which the chemist has at his command; for the state in which it places bodies, as will be seen afterwards, disposes them, so to speak, either to combine or to break connection, and to intensify or destroy that property which they have of combining under ordinary circumstances. When two compounds are mixed which do not produce a precipitate, it is supposed that the acids and bases which they contain are equally distributed; thus, if chloride of sodium be mixed with nitrate of potassium, there

will be an interchange of the acids and the bases. Nitrate of sodium and chloride of sodium will exist conjointly with nitrate and chloride of potassium, and these changes will take place in the proportion of the equivalency of the two bases; but if chloride of sodium be mixed with nitrate of silver, supposing them to be employed in equivalent proportions, there will be a perfect interchange of acids. Chloride of silver will be thrown down as a white precipitate, and nitrate of sodium will remain in solution—

$$Na\,Cl + Ag\,NO_3 = Ag\,Cl + Na\,NO_3.$$

The insolubility therefore of a compound, if such an one can be formed by the substances employed, determines the decomposition. When chloride of calcium is made to react on carbonate of ammonia, a white precipitate of carbonate of lime is thrown down—

$$2\left\{(N\,H_4)_2\,O\right\}\,3\,CO_2 + 2\,(Ca\,Cl_2) = 4\,(N\,H_4\,Cl) + 2\,(Ca\,CO_3) + CO_2.$$

But if the mixture in the test tube be heated, the carbonate of lime will be gradually dissolved, chloride of calcium being again formed, carbonate of ammonia being driven off by the heat. In the first instance, the decomposition was determined by the insolubility of the compound produced by the interchange of acids; in the second, the action was reversed by heat; and therefore the volatility of a substance which can be produced by a reaction, determines the decomposition. It cannot therefore be said that there is any "elective affinity" on the part of any one of the constituent substances for the other, carbonic acid cannot be said to have a greater affinity for lime than it has for ammonia, because its attraction for either substance depends on the circumstances under which they are brought together.

To return to our first example, when chloride of sodium is mixed with nitrate of silver, chloride of silver is formed, it cannot be asserted that this is because chlorine has an elective affinity for silver; for if an element which is less energetic than chlorine be brought to act on chloride of silver, it will cause its decomposition, simply because its silver salt is less soluble in the solvent which dissolves chloride of silver than is the chloride. Iodine is much less energetic in its action than chlorine, which is able to separate it from one class of its compounds, and to replace it. Chlorine liberates iodine from a solution of iodide of potassium, and forms a chloride of that base; but iodine can expel chlorine from chloride of silver, iodide of silver being formed; for, if to a saturated solution of chloride of silver in ammonia, iodide of potassium be added, iodide of silver will be precipitated. Equal volumes of chlorine and

hydrogen, when placed in diffused daylight or in direct sunlight, unite, in the first instance slowly, in the latter with explosion, forming hydrochloric acid. Bromine, which in its energy stands between chlorine and iodine, as it does also in its density, does not unite with hydrogen under similar circumstances; but if both be passed through a tube, heated to bright redness, a combination is effected, and hydrobromic acid is formed. But iodine and hydrogen cannot be made to unite directly, their union is formed by indirect methods; and yet iodine is able to separate silver from its chloride. In the case of these hydrogen compounds, there are evidently manifested different degrees in affinity between hydrogen, chlorine, bromine, and iodine, as is also seen from the power which chlorine has of ejecting either of the others from their potassium salts (which as regards stability are similar to their hydrogen salts); and yet under other circumstances, iodine and bromine are able to replace chlorine in its combination with silver (for bromine does the same as iodine, only not so completely, its silver salt being more soluble in ammonia than that of iodine). With these instances before us, it is hardly possible to conceive that there is inherent in a substance a power of attraction or affinity, or whatever it may be termed, which leads it to select bodies with which to combine to the exclusion of others, it seems rather that this affinity depends on a particular state or condition of the bodies induced by heat, or by some other agent, which places them in a suitable state for combination. Silicic acid is so weak an acid, that even carbonic acid can separate it from its soluble compounds; whereas, at a high temperature, it can expel sulphuric, one of the strongest acids, as is seen in the manufacture of glass and other stable silicates, in which sulphate of soda or potassium is used. Again, steam, acted on by red-hot iron, is decomposed, an oxide of iron being formed, and hydrogen set free; but if hydrogen be passed over red-hot ferric-oxide, the hydrogen reduces it, and water is formed. In like manner, oxide of barium (BaO) heated to a certain temperature, about low redness, takes up another atom of oxygen, forming BaO_2, which it loses again at a higher temperature. The affinity of barium for oxygen, therefore, is altered by changes of temperature, and that of iron for the same element manifests itself in a greater or less degree, according to the way in which it is presented to it; the importance of these considerations will, it is hoped, be seen afterwards, when the constitution of complex compounds is described. Whatever may determine combination or decomposition, it is not certainly a property of the body, inherent in it,

such as was implied by the term electric affinity; for if it were so, why should oxygen unite with barium in one proportion at one temperature, and in another at a lower? Elements and compounds are found to behave differently under the action of the galvanic current, some going to the positive, others to the negative pole. When water is decomposed by electrolysis, the hydrogen is given off at the negative and the oxygen at the positive pole; also, when chloride of sodium is subjected to the same decomposing agent, chlorine is found at the positive and sodium at the negative pole; and from these observed properties oxygen and chlorine are called electro-negative, and hydrogen and sodium electro-positive. Other terms for these properties are employed, namely, chlorous and basylous: chlorous, like chlorine or electro-negative; basylous, or acting as a base, like hydrogen or electro-positive. These different states, the chlorous or basylous, also determine the affinity which bodies have for one another. A substance which is electro-negative to others which are electro-positive to it, unites with that which is furthest removed from it in its electric condition. Iron is electro-positive to copper, and if iron be placed in a solution of sulphate of copper, copper is precipitated, and iron takes its place in the solution; for iron, being further removed from SO_4 than copper, which is electro-negative to both, it combines with it to the exclusion of the copper. When substances are said to be electro-negative or electro-positive, it is not meant that they are so absolutely, but relatively to others which have a different condition; and even an element, is believed to be electro-negative to itself, that is, the atoms which form its molecule exist in these two different states.

When chlorine gas is passed into water, in the cold, only half of the chlorine can be precipitated by nitrate of silver; but on filtering off the precipitate, after sufficient nitrate of silver has been added to send down all that can be precipitated, the filtrate will contain the remaining half of the chlorine in a state of combination which cannot be disturbed by nitrate of silver. If, however, it be acted upon by some reducing agent, such for example as zinc and sulphuric acid, the remaining half of the chlorine can be precipitated by nitrate of silver. Here the chlorine passed into the water has decomposed a part of it, and has formed hydrochloric and hypochlorus acid—

$$Cl_2 + H_2O = H\,Cl + H\,Cl\,O.$$

Half of the chlorine has combined with electro-positive hydrogen, and the remaining half with the electro-negative residue of the water, HO. It will be easily seen that HO must be electro-negative, as

the electro-negative oxygen is only half saturated by the basic or electro-positive hydrogen. We therefore conclude that the molecule of free chlorine contained atoms in different states of polarity (an objection has been raised to the use of this word, lest confusion should arise between the idea which it is intended to convey and magnetic polarity); it is true that no one has yet discovered the nature of this property of atoms, but on investigation it may be found to be of a kind analogous to it. When the hypochlorous acid is acted on by the zinc and sulphuric acid, chloride and sulphate of zinc are formed, the hydrogen taking the oxygen of the hypochlorous acid to form water—

$$2\,(H\,Cl\,O) + 2\,(Zn) + H_2\,SO_4 = Zn\,Cl_2 + Zn\,SO_4 + 2\,(H_2O).$$

Here the chlorine has shown electro-negative properties, and has united itself to electro-positive zinc. When chlorine gas therefore is evolved in the free state, its atoms arrange themselves to form molecules, the one atom of the molecule having chlorous or electro-negative, the other basylous or electro-positive properties, and these atoms become chlorous or basylous according to the properties of the bodies with which they are brought into contact at the moment they are set free from the combinations in which they existed. This is an example of the polarity of atoms afforded by the *analysis* of the molecule of chlorine, and we shall see that the *synthesis* of a molecule of oxygen shows that its atoms possess similar properties. Peroxide of hydrogen $H_2\,O_2$, which is made by dissolving peroxide of barium in dilute hydrochloric acid—

$$Ba\,H_2\,O_2 + 2\,(H\,Cl) = H_2\,O_2 + Ba\,Cl_2 + H_2\,O,$$

holds its second atom of oxygen very feebly, so that one would expect it to act as an oxidizing agent in all cases. This, however, is not the case; for, if it be added to a solution of bichromate of potash, it changes the liquid from bright yellow to green by reducing the chromic acid, $Cr\,O_3$, to chromic oxide, $Cr_2\,O_3$. It also reduces the oxides of gold, silver, and platinum, leaving the metals, oxygen being set free, one-half coming from the peroxide of hydrogen, the other from the metallic oxide; and so violent is the action that if it be brought in contact, in a concentrated form, with oxide of silver, the decomposition takes place with considerable violence and rise of temperature. Here the oxygen is held feebly both by the peroxide of hydrogen and by the silver, and being in different electric states the two atoms are able to separate from their combinations and form a molecule of free oxygen. The action really is one of oxidation, for the atom of oxygen, in union with

the silver, oxidizes that of the peroxide, and oxide of oxygen, *i.e.*, free oxygen, is the result. This strange reaction was not for a long time understood until Sir Benjamin Brodie, who was the first to investigate this subject, pointed out, in a paper on "The Condition of Elements at the Moment of Chemical Change,"* that the oxygen in the peroxide of hydrogen and that of the oxide of silver were in two different polar states, the former in the positive, the latter in the negative. He says, "Were it, for example, a hydride of silver which was thus decomposed by the peroxide, and the decomposition of the substances attended with the formation of water, the experiment would have attracted no attention. On the view here given, the formation of the oxygen is as truly a chemical synthesis as the formation of water itself, and may be substituted for it in a chemical change. The oxide of silver is here reduced by the oxygen of the peroxide of hydrogen, just as in other cases it might be by the hydrogen itself, the formation of the silver being the corresponding fact in the decomposition of the oxide of silver to the formation of water in the peroxide of hydrogen, so that the change may be represented thus"—

$$\overset{+}{H_2}\,\overset{-}{O}\,\overset{+}{O}\,\overset{-}{O}\,\overset{+}{Ag}\,\overset{-}{Ag} = H_2O + O_2 + Ag_2.\dagger$$

Another instance of synthesis is found in the formation of a molecule of hydrogen by the action of hydrochloric acid on hydride of copper, which was discovered by Wurtz, who found that when hypophosphorous acid acted on sulphate of copper, a brown hydrate of copper was formed, having the formula Cu_2H_2; and that when this body was acted upon by hydrochloric acid, hydrogen was rapidly set free and subchloride of copper formed. This was very unexpected, because hydrochloric acid is generally believed to have no action on metallic copper.

$$Cu_2H_2 + 2\,(H\,Cl) = Cu_2Cl_2 + H_4.$$

In this case the hydrogen of the cupreous hydride is evidently electro-negative, and that of the hydrochloric acid electro-positive; and as the compound Cu_2H_2 is very unstable, being decomposed at 92° C., the atoms of hydrogen being in different polar states, unite to form free hydrogen.

A further example is afforded by the behaviour of iodine, when an iodide and an iodate are treated with a dilute acid. Iodide of potas-

* Phil. Trans., II., 1850, 759.

† In his paper, Sir B. Brodie uses the old notation thus—

$$\overset{+}{H}\,\overset{-}{O}\,\overset{+}{O}\,\overset{-}{O}\,\overset{+}{Ag_2^1}\,\overset{-}{Ag_2^1} = H\,O + O_2 + Ag.$$

sium, when pure, is not decomposed by hydrochloric acid, which is free from chlorine; nor is pure iodate of potassium decomposed by an acid, but when iodide and iodate are mixed, acetic acid sets iodine free, and the free iodine is built up of the atoms existing in the two different potash salts. This is just the reverse of the action which we before considered in the case of chlorine, with this difference, that when iodine is added to a solution of hydrate of potash, hydriodic acid, H I, is formed along with iodic, $H I O_3$, there being no compound of iodine with oxygen similar to hypochlorous acid, iodine having, under similar conditions, a more powerful affinity for oxygen than chlorine has. The molecules of iodine, as those of chlorine did, break up into their atoms, some of which exhibit basylous, while others show chlorous properties. It would occupy too much of our space to cite more of the many examples which might be brought forward to illustrate this point. Those who desire to follow up this very interesting and important subject, are referred to Sir B. Brodie's very able paper. The molecules of the elements, then, are composed of atoms with electro-positive and electro-negative properties, so that chlorine is Cl Cl, chloride of chlorine, one atom positive, the other negative to it, and the same is the case with the other elements. H H is hydride of hydrogen, and the molecule is, so to speak, as regards these properties, in a state of equilibrium. The electro-positive atom, H, cannot exist alone, nor can that which is electro-negative; so that when the atoms are set free from any combination they instantly unite together to form the free element, or with some other body in contact with them, and this is what is meant by the "nascent state," which is, as Sir B. Brodie says, really a polar state; for when zinc and sulphuric acid act together in the presence of water, hydrogen is evolved, and if any substance be present with which hydrogen forms compounds, for example, common arsenic or arsenious acid, $As_2 O_3$, arsenuretted hydrogen and water are formed—

$$6\,Zn + 6\,(H_2\,S\,O_4) + As_2\,O_3 = 6\,(Zn\,S\,O_4) + 2\,As\,H_3 + (H_2\,O).$$

Whereas, no arsenuretted hydrogen is produced if the hydrogen be passed over arsenious acid in the cold; in fact, no reaction takes place, and simply metallic arsenic and water are the products if the arsenious acid be heated while submitted to the action of free hydrogen.

LYELL'S GEOLOGICAL PHILOSOPHY.

SIR CHARLES LYELL may well be congratulated on bringing out the tenth edition of his "Principles of Geology." In his preface to this edition he tells us that it is now thirteen years and a-half since the ninth edition made its appearance, and he has found it necessary to re-write some chapters, to modify others, and to omit passages no longer conforming with the best views of the day. The "Principles" made their first appearance in 1830—1833, and in 1834 a re-publication of the whole with new matter was issued in four volumes. Looking back to these dates, the science which Sir Charles has so ably expounded, and to which his own researches and methods of thought have contributed so much, appears in a widely different condition to what it is at present. Only a few bold thinkers ventured to reject Archbishop Usher's Chronology, or to differ from the orthodox views of the very recent creation of our globe and "all that it inherit," and the consequence was that geological theories were all founded upon the belief that changes, which are now known to have resulted from the slow operation of ordinary causes, were produced by violent catastrophes and convulsions, sweeping many plants and animals from our globe, as a sponge cleans the diagrams from a blackboard, and leaving the ground clear for any number of fresh creations that seemed to be required.

It is easy—and especially so with the help which Lyell's own researches into the history of geological speculation affords—to show that some previous thinkers had been impressed with the erroneous character of such spasmodic conceptions of the order of nature, but to him more than to any other philosopher in our own country, or on the continent, belongs the distinguished merit of marshalling facts and arguments so as to give a sound direction both to the theoretical and the practical part of the science. So long as observers were content with irrational endeavours to account for all the facts they met with, by ascribing them to forces of tremendous violence operating in very brief spaces of time, the supposed geological past bore only a very faint resemblance to the actual present, and the different portions of terrestrial history conformed to no known or intelligible plan. We now know that although various sciences may be made to throw combined light on each other's paths, that each natural group of facts must be studied independently, and no generalizations admitted which they do not fairly warrant. The known facts of geology, fifty or a hundred

years ago, did not warrant the generalizations they were affirmed to support. Nothing actually seen or traced on the globe pointed to a beginning a few thousand years ago, or to the universality of one great deluge. Both those propositions belonged to another sphere of thought, and according to a logical method of procedure would never have been admitted as geological axioms. Finding the remains of water creatures, shell fish, etc., in vallies, on mountains, and in deep cuttings, would naturally have led to the thought that there was a time, or rather that there were times, when what is now dry land was river bed or sea bottom, but the orderly arrangement of many formations in which these relics of the past occurred should have contradicted the notion that a great deluge had done all the work, and would have done so long ago, if geologists had been true to their own science.

The study of existing causes was in a very imperfect state when Lyell began his labours. Not only had the facts to be accumulated concerning the action of rivers, floods, sea waves, rains, volcanoes, earthquakes, etc., at the present time, or within historical periods, but it was necessary to institute careful comparisons between their known effects and the appearances exhibited by formations of earlier date. This latter part of the inquiry was sadly hindered by the tendency to ascribe too much importance to negative evidence. If Lyell's views of the sufficiency of existing causes to account for all the formations the geologist can gain access to, were correct, the various groups of rocks and fossils which had been unfortunately named "primary," "secondary," and "tertiary," ought to stand to each other in regular family succession, and the younger formations ought to appear as the legitimate descendants of those preceding them. But the observed facts did not exhibit an orderly development of this kind. It seemed as if systems had passed away and other systems had arisen in a manner not consistent with orderly progress. The connecting links which Lyell's philosophy pre-supposed were frequently wanting, and in no way did he more conspicuously or brilliantly exhibit the true scientific spirit than in his resolute refusal to give undue weight to negative evidence. He argued that if the links had not been discovered they might hereafter be found, that we know far too little of the earth's structure to be entitled to assume non-existence from non-discovery; and research continually added to the proofs that past phenomena were explicable by reference to existing causes.

Most abundantlyhas the progress of field geology confirmed the anticipations of the great thinker to whose labours so much honour

is due. Link after link has been traced, and what is of scarcely less importance, strong proof has been found to show that an immense number of intermediate formations not yet discovered, must have existed, so that we are not entitled to assert that in any portion of the series, there were either violent breaks or violent alterations in the general plan.

The successive editions of Sir Charles Lyell's "Principles" have been proofs of the soundness of his method of inquiry. The new facts, while exploding other theories, have, in the main, established his, and when he has found most reason for changing or modifying particular opinions, he has been influenced by discoveries that have strengthened his main system. Thus, in early editions we find him a strong opponent of development theories, and yet when Darwin's great work appeared he was one of the first supporters of the doctrines it maintained. He would, no doubt, have exhibited more of the prophetic character if he had more accurately distinguished between the errors of speculations like those of Lamarck, and the fundamental truth which they imperfectly endeavoured to elucidate. Tested, however, by the action of existing causes the development theories of the pre-Darwinian period did not appear sound. Darwin for the first time brought an important group of existing causes into logical connection with past facts. He did for the organic world what Lyell had done for terrestrial rocks, and if the work was less complete it was because the subject was more difficult. Some sort of development theory is logically essential to Lyellian geology, and Sir Charles frankly accepted the first that came with sufficient evidence of its probability.

We have so recently discussed the Darwinian theory, and, in the INTELLECTUAL OBSERVER, we took so many opportunities of laying before our readers the most important discoveries recently made by geologists, that we need not follow Sir Charles Lyell in his elaborate and varied expositions. We find, in this new edition of his "Principles," an admirable *resumé* of recent facts and speculations, and we would especially recommend attention to the chapters on changes of terrestrial climate, and to the provisional attempts to arrive at the real date of certain formations. At p. 251, vol i., we find a very instructive map, showing the extent of surface in Europe known to have been covered by the sea since the commencement of the eocene period—a very distant date, if we could state it in historic time, but a geological yesterday, though, perhaps, millions of years ago. Spain, though presenting a solid mass of older land, was, at one time, since that epoch, divided by a sea from France. A great

sea may have stretched from Berlin and Dresden, through Poland, Finland, past Moscow and St. Petersburg to the White Sea, and through Denmark and Sweden, leaving the high land of Norway. The Black Sea and the Caspian may have been united at the time when the lower lands on the Volga and the Danube were submerged. What proportion of land was above water at any particular time, is very difficult to ascertain; but a mere inspection of this instructive map is sufficient to show that the climate of Europe must at certain periods, since the eocene epoch, have differed considerably from what it is now. As Sir Charles Lyell says, "some approximation has been made to an estimate of the amount of *sea converted into land* in parts of Europe, best known to geologists, but we cannot determine how much land has become sea during the same period, and there have been repeated interchanges of land and water in the same places, of which no account could be taken."

Lyell regards our existing continents as very ancient, notwithstanding minor modifications; but the term "ancient" has reference to chronologic rather than to geologic time, as even in the eocene period "the distribution of land and sea bore scarcely any resemblance to that now established."

The depth of the sea is much greater than the height of the land above it, and this fact exercises an important influence on the rate at which certain modifications take place. "The mean height of the land is only 1,000 feet, the depth of the sea, 15,000 feet. The effect, therefore, of vertical movements, equalling 1,000 feet in both directions, upward and downward, is to cause a vast transposition of land and sea in those areas which are now continental, and adjoining to which there is much sea not exceeding 1,000 feet in depth. But movements of equal amount have no tendency to produce a sensible attraction in the Atlantic or Pacific Oceans, or to cause the oceanic and continental areas to change places. Depressions of 1,000 feet would submerge large areas of existing land, but fifteen times as much movement would be required to convert such land into an ocean of average depth." Assuming that the average quantity of land and sea remains pretty much the same, and that the distribution of land and water is continually, though slowly changing, the condition of things may vary between a maximum aggregation of land on the equator, and a maximum at the poles, with sea at the poles in one case, and land at the other. The first would produce the warmest average of climate, and the latter the coldest, while between them all kinds of variations might occur. At present we seem "much nearer to the winter than to

the summer of the *annus magnus*, or great cycle of terrestrial climate."

Sir Charles Lyell discusses with great ability the climatic effects of astronomical changes, such as the inclination of the earth's axis, the occurrence of summer when the earth is nearest the sun, instead of when furthest, as at present, and many similar matters; and shows that, on the whole, variations in the distribution of land and water would be far more potent causes of vicissitudes of climate.

A very striking hypothetical section relates to the probable "comparative duration of the glacial and the antecedent tertiary, secondary, and primary epochs." If the glacial epoch was coincident with the last maximum eccentricity of the earth's orbit, as suggested by M. Croll, and with our northern winter's occurrence at the greatest distance from the sun, it is found from astronomical calculation that the epoch in question may have commenced a million years ago, and reached a maximum 210,065 years ago. But the marine shells of the glacial period, as compared with the present ones, show a change of only five per cent.—ninety-five per cent. being specifically identical with that of living animals. Thus one million of years would correspond with one-twentieth part of a complete revolution in marine species. In the older miocene formation, the marine shells, as a whole, differed from those now existing, and their date would, on this calculation, appear to be twenty millions of years ago. Between them and the beginning of the Cambrian period twelve similar changes may be traced, and thus the commencement of that period would be carried back 240 millions of years.

We give this merely as an illustration of the enormous demands upon time which modern speculations make, but looking to the probability that variations in the disposition of land and sea, according to laws not yet elucidated, had much more to do with changes of climate and species than any astronomical agencies, little weight could be attached to a calculation based on the latter class of facts. But other methods of reasoning do not lessen the probability that the series of modifications which we trace in successive formations, took place with extreme slowness, and with what, to our feeble conceptions, must appear a gigantic expenditure of time.

If science modifies theology, it cannot be said to imperil religion. It opens a grander perspective of creation than ignorance could have conceived. As Lyell observes, the more the idea of a slow and insensible change from lower to higher organisms, brought about in the course of millions of generations according to a preconceived plan, has become familiar to men's minds, the more conscious

they have become that the amount of power, wisdom, design, and forethought required for such a gradual evolution of life, is as great —might he not have said greater—"as is implied by a multitude of separate special and miraculous acts of creation."

Referring to the unwillingness to accept new ideas, so characteristic of barbarism and so detrimental to the progress of civilization, he remarks, "we are sometimes tempted to ask whether the time will ever arrive, when science shall have obtained such an ascendancy in the education of the millions, that it will be possible to welcome new truths, instead of always looking upon them with fear and disquiet, and to hail any important victory gained over error, instead of resisting the new discovery long after the evidence in its favour is conclusive."

Sir Charles Lyell has happily lived through a period in which great improvement has taken place in this respect, and he stands foremost in the ranks of those to whom society is indebted for the beneficial change. No science has done more than geology to emancipate the human intellect from superstitious trammels, and no other geologist has done so much to place that science upon a firm basis of sound theory and philosophic truth.

MARKINGS ON THE PLANET VENUS.

BY JOHN BROWNING, F.R.A.S.

On the afternoon of the 15th of March, I had been observing a remarkable group of sun spots, with a 10¼-inch silvered glass reflector. About half-past four P.M., the sun becoming partially obscured by some trees, I set Venus off upon the circles of the equatorial, and looking along the tube I saw that she was plainly visible to the naked eye, although the sun was shining brightly. Viewing the planet with a power of 185, I found definition above the average. The feature that first attracted my attention was a curious oblong white nebulous spot, of considerable dimensions, shining with far greater brilliancy than any other part of the disc. This spot was on the edge of the disc, and fully 80° from the southern horn. From the resemblance it bore to the cloud-like patches I have described on Mars (Intellectual Observer, September, 1867), I have little doubt that this spot was a highly reflective cloud in the atmosphere of Venus. Being within 10° of a line from the centre of the planet to the centre of the Sun, it was, of course,

in a position to receive the utmost amount of light from that luminary.

The northern horn was slightly blunted. More commonly the southern horn is shortened, but this doubtless depends on the phase. A trace of light was perceptible along the limb beyond the southern horn. The gradation of light from the terminator extended across one-third of the visible disc, the illuminated portion being about seven-tenths of the whole disc. Looking intently at the partially illuminated disc near the terminator, I was able to make out that the surface of the planet was covered with markings bearing a resemblance to the grey plains on the Moon. These dark markings seemed to be studded with white spots of various sizes. In fact the shaded part of the planet looked very like the Moon when three-quarters old, seen with an opera glass of low power through a thick mist.

Mr. De La Rue once mentioned to me that he had occasionally seen faint markings on Venus with his large reflector, but with this exception, I had never heard that any observer had recently succeeded in seeing them. During the last week, however, I have heard from Mr. With that using a 12-inch glass reflector, *unsilvered*, he has seen a cluster of bright spots at the S. limb, about 40° from the terminator. I find a white patch in nearly the same place on my own drawing. I have also heard from Mr. Huggins that he has, only a few days since, seen a good sized white spot near the N. horn on the terminator. The actual existence of such markings may therefore, I think, now be considered as tolerably well established.

Observers with *small* achromatics may hope to make out the markings, but with large apertures, Venus is a much easier object in a good reflector than in a refractor, the reason being that the reflector has no aberration of colour. I have previously referred to the method of using an unsilvered glass mirror. A silvered mirror may, however, be used with a solar eye-piece, containing a single surface-reflecting prism.

Such an arrangement gives as good results as an unsilvered mirror, and possesses the great advantage that it leaves the telescope unaltered for any other class of observations.

MICROSCOPICAL NOTES.

THE *Soirée* of the Royal Microscopical Society, on the 22nd ult., at King's College, was the most brilliant and successful the Society has given. The leading makers were well represented, and many objects of scientific, as well as popular interest, were exhibited. On another occasion we should advise that a larger number of Fellows should become exhibitors, and the excellent display of microscopes and objects by the Society, may be advantageously followed up on subsequent occasions.

A tank microscope by Mr. Ross, an adaptation of Nachet's pseudoscopic binocular, by Messrs. Murray and Heath; a new meteor-spectroscope with an enormous field, and a new reflecting goniometer by Mr. Browning, a remarkable clever and elegant adaptation of the kaleidoscope to the oxy-hydrogen lantern by Mr. How; Mr. Ackland's alcohol thermometer and optometer, and Fiddian's lamp chimney, of which we have lately spoken, by Mr. Collins, were among the principal instrumental novelties. Mr. Ladd exhibited his magnificent specimens of Iceland spar. The list of objects was decidedly above the average, both in point of beauty and scientific interest. Dr. Carpenter brought a beautiful series to illustrate the development of the Ophiuridæ, and we might specify many others who brought new and rare things. Much interest was excited by the opportunity for comparing a beautiful collection of early microscopes, belonging to the Society, to King's College, and to Mr. Williams, with the modern instruments. The famous "Martin microscope" was arranged to show a splendid specimen of crystallized bismuth belonging to Mr. Williams; with a power of about five inches it took in an object 1½ in. diameter. The Society did well to show some fine specimens from the "Beck collection" of bone sections recently presented, and objects from the Wallich collection, and from other of its late acquisitions.

Last year Stein published the second part of his great work "Der Organismus Der Infusionsthiere." It is a handsome folio about the size of those issued by the Ray Society, illustrated by sixteen well-executed copper plates, containing numerous figures. Compared with similar English publications its price is very high, which must seriously limit its sale. It consists of two divisions, the first detailing the latest investigations into the structure, reproduction, and development of Infusoria, and the second describing

those organisms which the author arranges under the order *Heterotricha*. Making the ciliary apparatus the basis of his classification, Stein recognizes five great orders of Infusoria, Peritricha, Hypotricha, Heterotricha, Holotricha, and, lastly, the "whip-bearers" (*geisseltragenden* species), or Flagellate Infusoria. The Acinetans he places between the two last. The Opalina, Trachelina, Enchelina, Paramecina, and Cinetochilina, have "the common character, that their entire bodies are uniformly ciliated, and that they have no oral ciliary zone." These form the Holotricha. Bursaria, Stentorina, and Spirostoma, like the preceding, have the entire body ciliated, and in addition they possess long powerful mouth-surrounding cilia—these are the Heterotricha.

Oxytrichina, Euplotina, and Aspidiscina have, for the most part, flattened bodies, with distinct dorsal and ventral sides, and the ciliation although varying in different families, is always confined to the ventral surface. These constitute the Hypotricha.

Vorticellina and Ophrydina, the Urcolarians, Tintinmus, Halteria, etc., have a zone of mouth-surrounding cilia, but not ciliated bodies. This division—the Peritricha—is not as well defined as the preceding.

It will be seen that whatever difficulties may occasionally occur in the classification of objects according to this system, it is simple and clear. M. Claparéde commenting upon it in the "Archives des Sciences," pronounces it a very natural classification, and expresses the belief that it will be generally approved.

With reference to the Acinetans, Stein has completely abandoned his well-known theory. After citing observations on their development, he says, "The Acinetans do not therefore belong to the development cycle of the Vorticellians, and as little do they to that of any other Infusoria; they are doubtless self-complete organisms. My Acinetan theory is laid aside."

M. Claparéde observes on this passage that it was very easy to make Stein's mistake, "the fact that the embryos of many Infusoria are furnished with suckers like those of the Acinetans readily led to the seductive hypothesis." Stein himself is quite entitled in withdrawing this hypothesis, to claim for it the merit of having promoted inquiries by which our knowledge has been largely increased. We purpose recurring to his book on several future occasions, and for the moment pass to other matters.

We have received from the authors an extract from the memoirs of the Societa Italiana de Scienze Naturali, entitled "Nota Sopra un Alciopede Parassito della *Cydippe densa, Forsk.*," by Professors

Edouardo Renato Claparéde, of Geneva, and Paolo Panceri, of Naples. They tell us that, while pursuing their researches among the numerous oceanic creatures brought by the currents into the Gulf of Naples, they met with elegant Beroids, which they believe corresponds with the *Cydippe densa* of Forskall, and which Gegenbauer describes under the name *C. hormiphora*. In some individuals of this species they noticed little bodies, which they at first took for tailed larvæ of a distoma; but the presence of others somewhat larger, and of small annelids alive in the stomach of the Cydippe, led to further investigation, and to the recognition of the creatures as belonging to the family Alciope. In their first stage these larvæ were about one millimeter in length, and the head was not distinct from the body, and was without appendages. The eyes were not protuberant, and were represented by a round crystalline lens, with a pigment layer behind it. In this condition it is represented in their plate as an oblong body slightly rounded and protuberant at the sides, with the tufts of cilia on each side. Their plate represents seven stages of growth in a very interesting manner. The eyes grow larger and more protruding, antennæ are developed, and the body exhibits numerous segments with rows of bristles. "The larva in the ultimate stage of our observations contained about thirty segments. The head exhibited the superior antennæ elongated and protruding, while the lower ones remained as tubercles. The eyes, more developed, had the form of those of adult Alciopi, and could be moved in various directions in connection with the head segment."

In this stage their figure represents the creature as having its body tinted with a delicate blue, the choroid of the eyes orange-yellow, the lens bluish. On each side of the back is a row of dark pigment spots, one for each segment. The feet, except the lower ones, are bristled. Length about one centimetre. From the development of the eyes and feet the authors consider that this creature, which they name *Alciopina parassitica*, could only be an internal parasite as a temporary arrangement. The situation, they think, might be favourable to the growth of their organs. In a note they say that M. Buchholz, of the University of Grieswald, had discovered in a Cydippe a larva of the same genus.

We have also received from Professor Claparéde "Observations sur les Rotateurs," from the "Annales des Sciences Naturelles." This paper contains many interesting observations, but we must now content ourselves with citing one. It refers to the *Melicerta ringens*, and its method of producing the currents which bring in

its food. "At the lower surface of the membranous vibratile organs of the Melicertæ there rises a crest, also membranous, which runs parallel with the margin of the organ, at a little distance from it. We may consider the vibratile organ as formed by a membrane doubled on its own margin in two plates, the upper one projecting notably beyond the lower one. The space between these two makes a deep channel, running all round the vibratile organ. The border of the upper plate carries the large cilia, which produce the illusion of rotating vessels. That of the lower plate also bears cilia. They move also, but their motion is very different from that of the upper cilia. They scarcely give rise to any optical illusion. The point of each cilium beats continually in the same plane, parallel to the margin of the apparatus; but the direction of this movement is inverse in the two halves of the vibratile organ." It is when a particle, entangled in the whirlpool of the upper cilia, touches the point of a lower one that its course is changed, and it is brought into the channel already mentioned.

We have also to thank M. Claparéde for a paper on the reproduction of plant lice.

ARCHÆOLOGIA.

About three-quarters of a mile to the north of Cockermouth, near the spot where the river Cocker enters the Derwent, is the site of a Roman station, not far from which is the village and mediæval castle of Papcastle. The castle was partly built of the materials taken from the station, and among inscribed stones found here was a fragment of an inscription referring to some event which took place on the Kalends of November, in the year when Gordian, a second time, and Pompeianus were consuls, answering to the 19th of October, 241, according to our reckoning. From another fragment of an inscription, we learn that this place was occupied by a troop of Frisians from Aballaba, for this seems to be the meaning of the words NVMERVS FRISIONVM ABALLAVENSIVM. At the date of the Notitia Imperii, the station of Aballaba (supposed to be Watch Cross), was occupied by a *numerus*, or troops of Moors, but it may perhaps, at an earlier date, have been occupied by Frisians, who had been removed to the station at Papcastle, the Roman name of which is not known.

During the last six months, Papcastle has been the scene of a considerable amount of excavations, done for the sewerage and

water-works, in the course of which very numerous relics of the Roman period have turned up, many of the smaller and more interesting of which were purchased and carefully preserved by Mr. Henry T. Wake, of Cockermouth. Among these were a quantity of leather, chiefly parts of shoes, one of which was a sole covered with very large-headed nails, in excellent preservation, resembling examples from Roman London collected by Mr. C. Roach Smith. None of the shoes were perfect, but some of the leather bears a resemblance to morocco, and other pieces to cordovan. One piece is distinctly stamped VICTC. Among the personal ornaments were several brooches, some of them peculiar in their character. One of them, which was round, and about the size of a modern bronze penny, bore distinct traces of blue enamelling, and an ornamentation of black dots, etc. It had a small boss in the middle, resembling in form the boss of an Anglo-Saxon shield. Other bronze fibulæ, all remarkably well preserved, presented well-known Roman forms; and several rings, mostly in bronze, beads, etc., were found scattered about. Among them was a small glass bead, of very delicate make. Pottery was found in great abundance, but nearly all in fragments. Some of the Samian ware was much ornamented, presenting figures of men and women, animals, mythological subjects, hunting scenes, etc. On one of the pieces of Samian ware the potter's stamp was SATVRNNI OF; two others were MAMMI, and FRI.CI MA, the first letters of the latter being lost. On a piece of one of the coarser sorts of pottery the letters PIRV were scratched. There were also examples of some classes of Romano-British pottery of rarer occurrence—some perhaps of rather a late date in the Roman period. One, which was found entire, is jug-shaped, with a handle, not unlike examples found in Anglo-Saxon graves. Fragments of glass were also found, but they were not very numerous. Among other objects were, a steel awl, five inches and a half long, in fine preservation; a steel punch, four inches and a quarter long; a whistle, made from a shank bone, with a hole neatly drilled through it; two counters of bone, with a bevelled edge, having a smooth surface with lines forming geometrical figures on one side, and a small hole in the centre of the other; and many iron nails, some of them of very curious forms. Among the more remarkable of the miscellaneous objects are two singular bronze discs, or dishes, both covered with green rust. The smaller example is ornamented with engraved lines, forming on the upper surface, or field, a pattern of concentric circles; it is two inches in diameter. The larger dish, which is three inches and one-eighth in diameter,

stands upon three ring-formed legs, and has in the centre of its field what appears to be the remains of an upright spike, which would lead us to suppose that it may have been a candlestick. Among the coins found in these excavations were a silver denarius of Nerva, much worn, and a denarius of base silver and another coin in second brass of Faustina junior, both in fair condition; but the others were mostly illegible. Among other things, a great quantity of oak timber was met with, in beams and boards; and, among animal remains, a boar's tusk, and some teeth, and numerous bones of oxen, deer, etc., some of them perfect, but others broken into pieces.

In trenching some ground recently at BERWICK-UPON-TWEED, in a place called the Inner Cow Close, a number of early sepulchral interments were found, apparently belonging to a regular cemetery. On each side of three of the skeletons were slabs of undressed stone, with rude stone coverings, on one of which was an incised cross, with a rose in the centre; on another, which was the cist of a child, there was a Latin cross. In another part of the ground the foundations of a tower-like building, of sound masonry, were discovered, in front of which was a wall four feet thick, which was traced to a distance of ninety-four feet long. The tower-like building was twenty-three feet square, and there was a space of twenty feet between it and the wall. The masonry was pronounced, we know not on what authority, to belong to the Norman period.

Interesting discoveries have been recently made in the ruins of GUISBOROUGH ABBEY, in Yorkshire, in the course of excavations directed by Captain Chaloner, the present proprietor of the estate. A trench was carried across the site of the church at about 200 feet from the east window, in a line with the outer wall, and a large doorway, with the remains of early English pillars in Purbeck marble, was discovered, probably an entrance from the church into the quadrangular court. Among the great mediæval barons whose bodies were interred in this part of the church, was Robert Bruce, Lord of Annandale, the competitor for the crown of Scotland with John Baliol, who died in 1294. In the course of the present excavations, there was found immediately before the high altar a quantity of heraldic tiles bearing the arms of Bruce, and a few inches beneath the pavement, in the very centre of the choir, at the foot of the steps on which the high altar is presumed to have stood, a stone coffin, six feet eight inches by two feet two inches, which may perhaps have contained the remains of Baliol's competitor. The skeleton was that of a tall and aged man, and its identification is

not very certain, for it may have been that of the founder of the monastery, an earlier Bruce, who fought in the ranks of King William at Hastings, and was the head of the great family of Bruce in the north. About twelve feet from this spot lay another stone coffin, with a complete skeleton in it. The heraldic tiles discovered in this part of the church were of great beauty, and many of them of no inconsiderable interest. The ruins of the central tower were found just as it had fallen, and under the masses of broken masonry were three large monumental slabs. At the depth of five feet from the surface, in the remains of an oak coffin, lay a skeleton which is stated to have been found, on careful measurement, to have been six feet eight inches in height. With it were found two circular bronze buckles, like those displayed in the heraldry of the fourteenth century.

T. W.

PROGRESS OF INVENTION.

Arrangement for Hanging Pictures.—A very simple arrangement has been patented and one which seems to offer many advantages over the very unsightly method now in use. A long piece of sheet iron, the length required for the side of the room, a few inches wide, is bent in the direction of its width in a semicircular or other ornamental form, but its lower edge is turned up the whole length sharply, so as to form a receptacle for hooks which can be hung on to it, at any distance apart; to these hooks, the cords by which the pictures are hung, are fixed: the hooks may be made very ornamental in stamped metal, or in any other way according to taste. The whole length of bent iron is fixed to the wall by wood plugs; a thin casting would answer equally as well as sheet iron, and both can be ornamented with stamped brass, embossed and decorated paper, or by decorated designs in gold and colour. The whole might be made to supplement the room cornice, and placed at an interval below it, would form a sort of frieze which might have its special decoration. The concave side of the iron bar is of course to be turned to the wall, the outer which faces to the room having the appearance of a moulding. This invention seems to afford a means for wall decoration in good taste, in lieu of what has hitherto been an unsightly makeshift. The name of the inventor is W. Potts.

Improvements in Numbering Hall Doors.—Who has not felt the annoyance of having to ascend flight after flight of steps on a dark night to ascertain the number of the house which he intends visiting? Messrs. Drury and Westrup have patented a method by which this annoyance

may be removed in a very simple and efficient manner, and without in any way disfiguring the street door. They propose to have the knocker so made, that, in the upper part of its scutcheon an open space shall be left, forming a sort of medallion, in this is to be placed a piece of ground or opaque white glass, on which the number of the house is to be painted in black figures. They will be conspicuous by daylight, but much more so at night, when the gas is lighted in the hall, as they will act as a transparency. It is easy to see how such an arrangement can be readily made an ornamental feature. Where bells are used instead of knockers, the medallion can be made separately and fixed to the door in the most approved situation. Of course in both cases the part of the woodwork behind the medallion must be cut away to allow the light to shine through the glass at night. Where desired the name of the occupant, can be added to the number of the house. It would be well if parish authorities would have the number of the nearest house at the corner, where two streets join, marked legibly on the glass of the gas lamps, and also the name of the street; this improvement together with Messrs. Drury and Westrup's invention would do much to render evening visiting less difficult than it is at present.

Hydraulic Self-Acting Vent Peg.—The servant has left out the vent peg and so six or seven gallons of beer are comparatively spoilt, at least the pleasure experienced in drinking them is very much lessened. Mr. E. T. Hughes has put into our hand a remedy for this evil, and one which the most careless and stupid servant would have some trouble to render of no effect. He makes a small cylinder, open at the top, closed at the bottom, inside which is placed a smaller tube passing through the bottom of the cylinder to which it is soldered water-tight. Here we have tube within tube, the inner or smaller one projecting below its outer covering two or three inches, and this projecting part is made to taper, so that it may be fixed into the beer barrel; the outer cylinder is pierced with holes, rather above its middle, and water is poured into it, between it and the smaller tube; the water of course cannot stand at a higher level than the holes. A small metal bottle is made with an orifice rather larger than the smaller tube, over which it is placed bottom upwards, the small tube projecting into its interior: there is therefore communication between the inside of the barrel, and the inside of the bottle by means of the small tube, and the density of the air in both vessels will be the same. Now when liquid is drawn out of the barrel, the air in it will be rarefied, and so will that in the bottle of the vent peg, and as the orifice of this dips into the water between the two cylinders but a short distance, the air outside will force its way through the water into the bottle and then to the barrel, and no more will pass in than is sufficient to take the place of the liquid which has been drawn out.

LITERARY NOTICES.

CELESTIAL OBJECTS FOR COMMON TELESCOPES. By the Rev. T. W. Webb, M.A., F.R.A.S., Incumbent of Hardwick, Herefordshire. Second edition, revised and enlarged. (Longmans.)—By universal consent of observers in this country, Mr. Webb's "Celestial Objects" has taken the place of a standard text-book, and its value will not be lessened by the promised second edition of Admiral Smyth's larger and costlier work. In the present edition Mr. Webb has added angles of position to his list of double stars, and has given three new appendices: the first, containing the names of all the principal lunar objects, arranged alphabetically; the second, supplying a list of objects in the southern hemisphere, selected from Sir J. Herschel's observations; the third, exhibiting all the stars, etc., mentioned in the body of the work, arranged in order of right ascension, corrected to 1870. In other respects the changes introduced in this edition are very slight, but we notice an interesting sketch, copied from Pastorff, of the transit of the comet of 1819 over the sun, and an instructive view of the extinct crater of Haleakala, to illustrate the resemblance between lunar and terrestrial volcanoes.

As English observers are much indebted to Mr. Webb for the judicious pains he took to introduce silvered mirror telescopes, we are surprised that he did not amplify the chapter on the telescope to say something about them. With a book so well known and so highly appreciated, we have little more to do than to mention the appearance of a new edition, which we know has been wanted for some time, and which those who survey the glories of the heavens will be anxious to obtain.

MAN'S ORIGIN AND DESTINY, Sketched from the Platform of the Sciences: A Course of Lectures delivered before the Lowell Institute in Boston, in the winter of 1865-6. By J. P. Lesley, Member of the National Academy of the United States, Secretary of the American Philosophical Society. (Trübner and Co.)—The subject which Mr. Lesley has undertaken to elucidate might well occupy the lifetime of a great scholar and a profound thinker. To sketch "Man's Origin and Destiny from the Platform of Science" would demand the highest qualifications, the most accurate treatment; and, when attempted in eleven slap-dash lectures, full of slang and vulgarity, the result cannot be of a very satisfactory kind. That Mr. Lesley has brought together a considerable mass of information will not be denied. He seems an omnivorous reader, and always ready to be an universal expounder. Geology, astronomy, architecture, language, ethnology, or theology, it matters not which—he can talk about any, or discourse upon all in a rushing, voluble, helter-skelter style, perfectly unsuited to a serious subject, and horribly offensive to good taste. That such methods of dealing with questions of great moment should have been tolerated at the Lowell Institute excites our surprise, and that after two years' time for reflection their author

should deem them fit for the press, indicates an astounding power of self-satisfaction, and inability to perceive glaring defects.

To glorify the present, Mr. Lesley indulges in preposterous deprecations of the past. Ancient science, he declares, had "no purpose in its investigations, no use in its results." "The mathematics of the ancients," we are told, "could produce nothing higher than astrology." Of course it does not matter for this sort of disquisition that Hipparchus discovered the precession of the equinoxes, catalogued the stars, and calculated the motions of the sun and moon. The "only intellectual tool above the level of their senses, which the ancients had to work with," Mr. Lesley discovers "to have been their quick and fertile imagination." A gentleman who views the past in this way is not likely to be a very accurate guide to the present, or a sound prophet of the future. In treating modern science, though many things are stated with tolerable correctness, we notice the same raw haste in assertion, and a striving for effect. Then we are told of the members of the animal kingdom, "they are each and all perfectly and beautifully adapted to their circumstances—the mollusca to the water, the articulata to the air, the vertebrata to the land, and the radiates to the places and times where air and water meet." A moment's reflection, or reference to any text book, would have shown the absurdity of this attempted division. Land mollusca, non-flying articulata, and aquatic vertebrata, are common enough, and well adapted to their mode of life. From Mr. Lesley's account of the matter, it might appear that all snails lived in the water; that crabs—which belong to the articulata—were in the habit of flying, and that fishes were destitute of vertebræ.

As a mild specimen of the vulgarities of the book, take the following: "One kind of blood is metal to the acid of another; mix them in generous proportions, and you have Hare's calorimoter on a cosmical scale; you can burn up with it the past, or electrotype with it the future. When the effervescence ceases, the creator walks away. The apparatus is useless until it is charged anew." Or this mode of telling the story of Pelops—"His prime offence was that of divulging to mortals the secrets of the Gods. His second offence was the diabolical trick which he played upon his Olympian guests, in cooking his own boy Pelops, and serving him up as a ragout, to see if their omniscience would discover what they really ate. Mercury restored the boy to life. . . His fresh beauty now ravished the heart of Neptune, who carried him in his own golden chariot to the top of Olympus, until the rest of the enraged deities, after a furious knock-down and drag-out fight in the royal dining-hall, had settled his father's hash; then he was carried back to rule in his father's stead." Notwithstanding a certain sort of cleverness, we fear Mr. Lesley's "hash" will be deemed bad cookery by any judge of decency or taste.

NOTES AND MEMORANDA.

New Reaction of Albuminoids.—It is stated, in the "Ann. der Chimie. et Ph.," that sulphuric acid containing molybdic acid colours the above-named matters an intense blue. Grains of wheat cut through the middle, and muscular fibre exhibit it.

Giant Synapta.—M. Semper, in his "Reiser. im Archipel. der Philippinen," describes creatures of this kind five, and even seven, feet long. The natives call them "sea-serpents." He states that the "anchors," so well known to microscopists, are not organs of locomotion, and are not under the control of voluntary muscles.

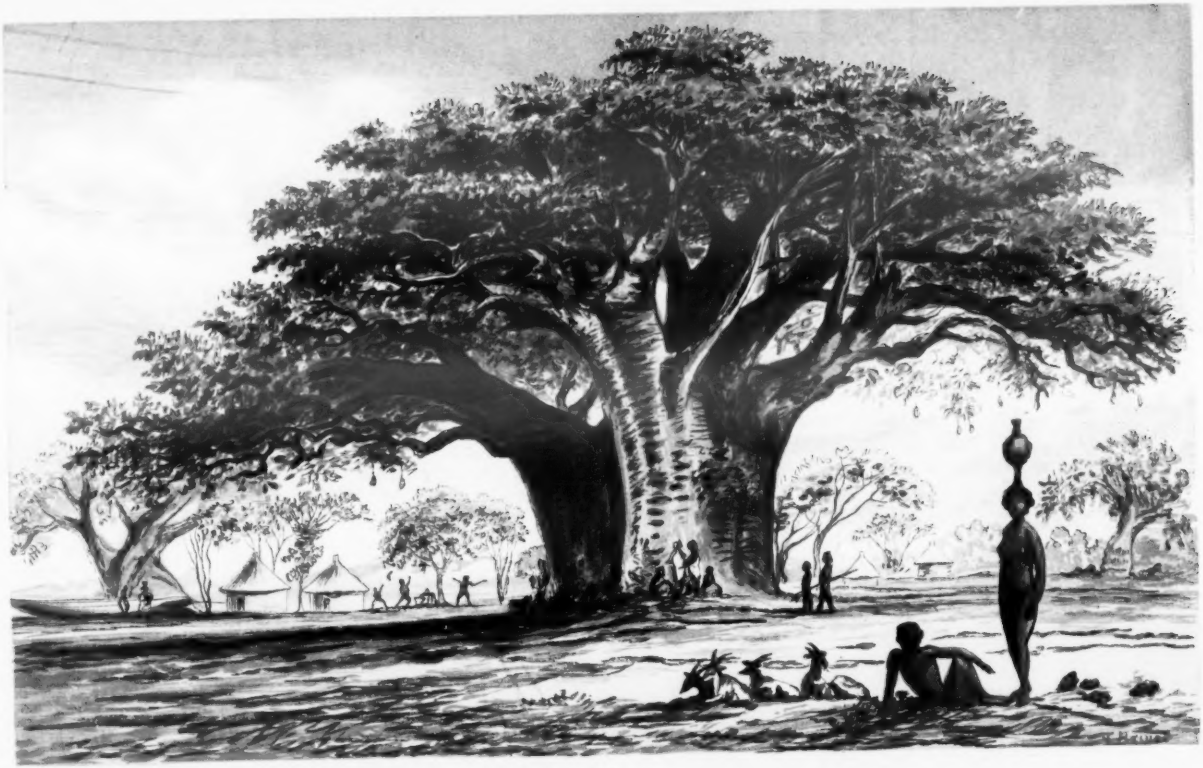
The Carboniferous Rocks of Pendle Hills.—Mr. Hull recently communicated a paper to the Geological Society on the above formations. He considers the aggregate thickness of the coal-measures, the millstone grit, and the Gordale series, to be 18,635 feet in the Burnley district, while in Leicestershire it has dwindled down to 3100 feet. The source of these sediments he thinks to have been a primæval Atlantis, a view which he considers to be strengthened by the fact that the carboniferous sedimentary strata of North America also swell out towards the north-east, and become attenuated towards the south and west.

Growth of Mineral Veins.—"Proc. Roy. Soc.," No. 100, contains a paper by Mr. J. A. Philips on the Gold Fields of California, in which, among other matters, he describes the growth of mineral veins, about seven miles from the Comstock silver mine, in the State of Nevada, in which boiling springs are active. One group of crevices in the rock comprise five longitudinal springs, extending in parallel lines for more than 3000 feet. Sulphur, silica, and anhydrous oxide of iron are deposited; the silica and iron forming semi-crystalline bands. Another fissure exhibits a silico-metalliferous deposit. He arrives at the conclusion that quartz veins have generally been produced by slow deposition from aqueous solutions of silica. That gold may be deposited from the same solutions appears from the presence of that metal in pyrites enclosed in silicious incrustations, as well as from the fact of large quantities of gold having been found in the interior of the stems of trees, which, in deep diggings, are often converted into iron pyrites. Mr. Philips thinks the sulphide of iron may be in some way connected with the solvent by which the precious metal is held in solution.

Formation of Asphalt.—M. Knab affirms, in "Comptes Rendus," his belief that the asphalt of the Val de Travers, Switzerland (or limestone impregnated with bitumen) was formed by beds of mollusks decomposed at a high temperature, and under great pressure, in a deep sea. Free bitumen he thinks formed by a similar decomposition, but at a pressure insufficient to force it into the shells of the mollusks. Petroleum he regards as formed in the same way, at a lower temperature, but under considerable pressure. Beds of fossil oysters, without bituminous matter, he supposes to have been under conditions which allowed the hydrocarbon to evaporate.

Fossil Coot from the Mauritius.—Mr. Alph. Milne Edwards read a paper before the Academie des Sciences, describing a recently discovered fossil coot (Fulica) from the Mauritius. The bones indicate a bird of much larger and heavier structure than those of existing species, and resemble *Fulica gigantea* more than any other.

Two Types of Horse.—M. A. Sanson states, in "Comptes Rendus," that there are two distinct types of horse hitherto confounded under the designation Arab or oriental. They are both Brachycephalus, and have their origin in different geographical districts, and are of different race. The oriental or Asiatic type has six lumbar vertebræ, the Arabian or African has only five, which is the number found in the ass or zebra.



BAOBAB,

60 feet in circumference, at Nyaruka Village, on the Zambesi, South East Africa, November 14, 1850, 4 p.m.

BAOBAB,

50 feet in circumference, at Nyaruka Village, on the Zambesi, South East Africa, November 14, 1859, 4 p.m.